

EXPANDING FIXED-WING AIRCRAFT CAPABILITY  
IN US ARMY AVIATION OPERATIONS

A thesis presented to the Faculty of the U.S. Army  
Command and General Staff College in partial  
fulfillment of the requirements for the  
degree

MASTER OF MILITARY ART AND SCIENCE  
General Studies

by

NEIL T. CHAFFEE, MAJ, USA  
B.S., Texas A&M University, College Station, Texas, 1994

Fort Leavenworth, Kansas  
2009

Approved for public release; distribution is unlimited.

REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. <b>PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.</b>					
1. REPORT DATE (DD-MM-YYYY) 12-06-2009		2. REPORT TYPE Master's Thesis		3. DATES COVERED (From - To) AUG 2008 – JUN 2009	
4. TITLE AND SUBTITLE  Expanding Fixed-Wing Aircraft Capability in US Army Aviation Operations				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)  MAJ Neil T. Chaffee				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army Command and General Staff College ATTN: ATZL-SWD-GD Fort Leavenworth, KS 66027-2301				8. PERFORMING ORG REPORT NUMBER	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION / AVAILABILITY STATEMENT Approved for Public Release; Distribution is Unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT The large battlespace in Iraq and Afghanistan has exposed an existing time and distance intra-theater airlift “gap” within the Department of Defense that cannot be met with Army tactical helicopters like the CH-47 Chinook and UH-60 Blackhawk or larger Air Force cargo airplanes like the C-130 Hercules and C-17 Globemaster III. This study explores the logic behind expanding Army fixed-wing aircraft roles and missions. Acquiring, integrating and operating a larger number of C-27J Spartan cargo airplanes to assume or supplement existing utility and cargo helicopter missions is a more capable, flexible, efficient and economical solution to meeting Army intra-theater airlift mission requirements. The thesis reviews what has historically prevented the Army from acquiring and employing a larger amount of cargo airplanes. The thesis then explains why it is necessary for the Army to increase airlift capacity to better support a more modular and expeditionary ground force while conducting Full Spectrum Operations in the current and future Contemporary Operating Environment. The thesis provides justification as to why the Army should employ a greater percentage of cargo airplanes as opposed to utility or cargo helicopters with respect to capability, flexibility, efficiency and cost. The thesis concludes with a recommendation to better balance the Army's fixed-wing and rotary-wing fleet that meets the needs of the Interim and Future Force.					
15. SUBJECT TERMS Army Aviation, Army Fixed-Wing, Joint Cargo Aircraft, C-27J Spartan, Intra-Theater Airlift Gap, Cargo Airplanes					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT (U)	b. ABSTRACT (U)	c. THIS PAGE (U)			19b. PHONE NUMBER (include area code)
			(U)	135	

Standard Form 298 (Rev. 8-98)  
Prescribed by ANSI Std. Z39.18

MASTER OF MILITARY ART AND SCIENCE  
THESIS APPROVAL PAGE

Name of Candidate: MAJ Neil T. Chaffee

Thesis Title: EXPANDING FIXED-WING AIRCRAFT CAPABILITY IN US ARMY  
AVIATION OPERATIONS

Approved by:

\_\_\_\_\_, Thesis Committee Chair  
David W. Christie, M.A.

\_\_\_\_\_, Member  
Sean N. Kalic, Ph.D.

\_\_\_\_\_, Member  
Stephen L. Melton, M.P.A.

Accepted this 12th day of June 2009 by:

\_\_\_\_\_, Director, Graduate Degree Programs  
Robert F. Baumann, Ph.D.

The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

## ABSTRACT

EXPANDING FIXED-WING AIRCRAFT CAPABILITY IN US ARMY AVIATION OPERATIONS, by MAJ Neil T. Chaffee, 135 pages.

The large battlespace in Iraq and Afghanistan has exposed an existing time and distance intra-theater airlift “gap” within the Department of Defense that cannot be met with Army tactical helicopters like the CH-47 Chinook and UH-60 Blackhawk or larger Air Force cargo airplanes like the C-130 Hercules and C-17 Globemaster III. This study explores the logic behind expanding Army fixed-wing aircraft roles and missions. Acquiring, integrating and operating a larger number of C-27J Spartan cargo airplanes to assume or supplement existing utility and cargo helicopter missions is a more capable, flexible, efficient and economical solution to meeting Army intra-theater airlift mission requirements. The thesis reviews what has historically prevented the Army from acquiring and employing a larger amount of cargo airplanes. The thesis then explains why it is necessary for the Army to increase airlift capacity to better support a more modular and expeditionary ground force while conducting Full Spectrum Operations in the current and future Contemporary Operating Environment. The thesis provides justification as to why the Army should employ a greater percentage of cargo airplanes as opposed to utility or cargo helicopters with respect to capability, flexibility, efficiency and cost. The thesis concludes with a recommendation to better balance the Army’s fixed-wing and rotary-wing fleet that meets the needs of the Interim and Future Force.

## ACKNOWLEDGMENTS

This thesis was written with the intent to recognize the value of Army fixed-wing aircraft operating in partnership with rotary-wing assets on the modern battlefield and during peacetime contingencies. Army Aviation continues to make a difference every day in Iraq and Afghanistan through the valiant efforts of many dedicated aviators and non-rated aircrew members flying some of the best military aircraft on the planet. Above the Best!

I want to acknowledge the invaluable assistance and latitude that my committee and other Command & General Staff College staff gave during the writing of this thesis. Many thanks to Mr. David W. Christie, Mr. Stephen L. Melton and Dr. Sean N. Kalic for their mentorship and guidance throughout this process. The technical advice from the Air Force Element at Fort Leavenworth also proved to be extremely useful and educational during the research and writing process.

Finally, I want to thank my beautiful wife Brooke and our two children Devyn and Travis. Their support kept me energized and focused on writing about one of my biggest passions in life – Army Aviation.

## TABLE OF CONTENTS

	Page
MASTER OF MILITARY ART AND SCIENCE THESIS APPROVAL PAGE .....	iii
ABSTRACT .....	iv
ACKNOWLEDGMENTS .....	v
TABLE OF CONTENTS .....	vi
ACRONYMS .....	ix
ILLUSTRATIONS .....	xii
CHAPTER 1 INTRODUCTION .....	1
Introduction.....	1
Background .....	1
Primary Research Question .....	3
Secondary Research Questions .....	3
Significance .....	4
Assumptions.....	4
Definitions .....	5
Limitations .....	8
Delimitations.....	8
Conclusion .....	9
CHAPTER 2 LITERATURE REVIEW .....	10
Introduction.....	10
Service and Joint Doctrine .....	10
Army Doctrine .....	11
Air Force Doctrine .....	15
Joint Doctrine.....	15
Government and Military Reports .....	16
Transformation and Modernization Documents .....	17
Army Aviation Future Concept Documents .....	18
Congressional Research Service Reports .....	19
Future Cargo Aircraft and Joint Cargo Aircraft Documents and Reports .....	22
Historical Documents .....	23
Professional Journals, Magazine and Publications .....	24
Analysis of the Literature .....	26
Gaps in the Record.....	27

Trends .....	28
Significance of Thesis to Existing Literature .....	28
Conclusion .....	29
<b>CHAPTER 3 RESEARCH DESIGN.....</b>	<b>30</b>
Introduction.....	30
Steps Taken to Obtain Information.....	30
Collection and Analysis .....	31
Strength and Weaknesses of Methodology.....	34
<b>CHAPTER 4 HISTORICAL BACKGROUND .....</b>	<b>36</b>
Introduction.....	36
Acts of Legislation and Formal Service Agreements .....	36
Evolving Doctrine and the Airmobile Concept .....	39
Small Airlifters in Vietnam.....	42
Small Airlifters for Alternate Roles.....	44
Recognizing the Need for Small Airlifters .....	45
Unity of Effort and Interservice Cooperation .....	47
Conclusion .....	48
<b>CHAPTER 5 FINDINGS AND RESULTS.....</b>	<b>50</b>
Introduction.....	50
The Need for More Intra-Theater Airlift .....	51
The Joint Cargo Aircraft (JCA) Program .....	53
New Vision, Doctrine and the Way Ahead.....	57
Army Aviation Support to Ground Forces .....	61
Transforming to Meet the Intra-Theater Airlift Needs of Ground Forces .....	66
The Army's Intra-Theater "Airlift Gap" .....	69
Airplane and Helicopter Comparison .....	70
Airlift Requirements of the BCT .....	72
Comparing Capability, Flexibility and Efficiency.....	74
Assessing Airlift Capability.....	81
Efficient Transloadability and Interoperability.....	87
Aircraft Costs .....	90
Conclusion .....	95
<b>CHAPTER 6 CONCLUSIONS &amp; RECOMMENDATIONS.....</b>	<b>97</b>
Introduction.....	97
Interpretation of the Findings .....	97
Recommendations.....	102
Conclusion .....	103

APPENDIX A: KEY ACTS, AGREEMENTS, DIRECTIVES & MEMORANDUMS SINCE 1947.....	105
APPENDIX B: DIAGRAMS OF HEAVY, STRYKER AND INFANTRY BCT FORMATIONS.....	112
APPENDIX C: AIRCRAFT SPECIFICATIONS .....	113
APPENDIX D: IBCT, SBCT AND HBCT CONSUMPTION RATES AND RESUPPLY REQUIREMENTS.....	117
REFERENCE LIST .....	119
INITIAL DISTRIBUTION LIST .....	123



## ACRONYMS

ACL	Allowable Cabin Load
AE	Aeromedical Evacuation
AO	Area of Operation
AOR	Area of Responsibility
APOD	Aerial Port of Disembarkation
APOE	Aerial Port of Embarkation
ASE	Aircraft Survivability Equipment
ASLT	Assault
BCT	Brigade Combat Team
CAB	Combat Aviation Brigade
CASEVAC	Casualty Evacuation
CDD	Capability Development Document
COE	Contemporary Operating Environment
COTS	Commercial Off The Shelf
CSAR	Combat Search & Rescue
DOD	Department of Defense
DOTMLPF	Doctrine, operations, training, materiel, leadership and facilities
DS	Direct Support
FARP	Forward Arming & Refueling Point
FBCT	FCS Brigade Combat Team
FCA	Future Cargo Aircraft
FCS	Future Combat System
FM	Field Manual

FOB	Forward Operating Base
FSO	Full Spectrum Operations
GS	General Support
GSAB	General Support Aviation Battalion
GWOT	Global War on Terrorism
HBCT	Heavy Brigade Combat Team
HMMWV	High Mobility Multipurpose Vehicle
IBCT	Infantry Brigade Combat Team
ICD	Initial Capabilities Document
JCA	Joint Cargo Aircraft
JFC	Joint Force Commander
JOA	Joint Operations Area
JP	Joint Publication
JTF	Joint Task Force Commander
CIAS	Knots Indicated Airspeed
LOC	Lines of Communication
MEDEVAC	Medical Evacuation
MSL	Mean Sea Level
NG	National Guard
NM	Nautical Mile
NVG	Night Vision Goggles
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
OSA	Operational Support Airlift
PA	Pressurize Altitude

QRM	Quadrennial Roles and Missions
ROAD	Reorganization Objective Army Division
ROMO	Range of Military Operations
SBCT	Stryker Brigade Combat Team
SPOD	Sea Port of Disembarkation
SPOE	Sea Port of Embarkation
STOL	Short Take Off and Landing
TAB	Theater Aviation Brigade
TAOG	Theater Aviation Operations Group
TS/MC	Time Sensitive/Mission Critical
USAF	United States Air Force
USAR	United States Army Reserve
VTOL	Vertical Take Off and Land

## ILLUSTRATIONS

	Page
Figure 1. Army Airlift .....	2
Figure 2. Airlift Formulas .....	33
Figure 3. Key Acts, Agreements, Directives & Memorandums Since 1947.....	37
Figure 4. C-27J Overview .....	54
Figure 5. Brigade-Sized Modular Formations.....	59
Figure 6. Army Aviation Missions.....	62
Figure 7. Future Force Functions Concepts and Mission Linkage.....	62
Figure 8. Diagram of the composite Theater Aviation Brigade (General Support) .....	65
Figure 9. Inter and Intra-Theater Movement.....	67
Figure 10. Army Aircraft Comparison Chart .....	76
Figure 11. Payload Weight & Range Comparison .....	79
Figure 12. Airspeed Comparison.....	80
Figure 13. Transport Capability Rates .....	83
Figure 14. C-27J Transport Capabilities. ....	88
Figure 15. C-27J Focused Logistics Support Concept .....	89
Figure 16. Purchase Cost Comparison .....	91
Figure 17. Operating Cost Comparison.....	92
Figure 18. Mission Profile Comparison .....	94
Figure 19. Purchase and Operating Cost Comparison .....	95
Figure 20. Payload and Range.....	100

## CHAPTER 1

### INTRODUCTION

#### Introduction

This study examines the possibility of expanding fixed-wing aircraft roles and missions in the United States Army. Acquiring, integrating and operating a larger number of light cargo airplanes to assume or supplement existing utility and cargo helicopter missions is a more capable, flexible, efficient and economical solution to meeting Army intra-theater airlift mission requirements.

#### Background

Despite the best efforts of the military services to define individual roles and missions, the fact remains that each has the inherent responsibility to support specific needs in peacetime and wartime. For the Army, significant restrictions have historically existed, and still exist, for purchasing and operating fixed-wing aircraft to supplement Army-specific mission requirements. Consequently, Army Aviation has evolved into a highly mobile air capability that primarily operates a large fleet of rotary-wing aircraft and a small fleet of fixed-wing aircraft in 15 mission categories. But due to past service agreements the Army has historically relied more heavily on helicopters to conduct service-specific organic functions to support the land force. Helicopters generally have significant fuel range limitations and are much more expensive to operate and maintain than similar sized airplanes. Additionally, the use of utility and cargo helicopters for dedicated intra-theater airlift functions serves to reduce the availability of tactical aircraft like the CH-47 and UH-60 for tactical missions.



Figure 1. Army Airlift

Source: Army Fixed-Wing Program Office, *Joint Cargo Aircraft Overview Brief* (Redstone Arsenal, AL, 2008), 26.

Army Transformation has caused the service to evaluate seriously and take action to meet the aerial sustainment requirements of the Interim and Future Force. This new force structure will place greater reliance on aerial-distribution platforms, providing responsive support across an expansive battlespace, perhaps to multiple locations. Fortunately, the responsibilities for the intra-theater airlift mission have evolved over time to respond to the changing operating environment and fielding of enhanced capabilities. Lessons learned from Operations Enduring Freedom and Iraqi Freedom have reshaped the Department of Defense intra-theater airlift vision (QRM 2009, 19). In 2007, the Army and Air Force signed the Joint Cargo Aircraft (JCA) Memorandum of Agreement which acknowledges the merger of two separate programs into one and outlines the way ahead for both services to share a common airlift platform and the intra-theater airlift mission.

The United States Armed Forces are conducting operations in an era of persistent conflict and air assets are clearly a combat multiplier on the modern battlefield. The Army is engaged in combat operations in Afghanistan and Iraq with a limited number of

tactical airlift assets to conduct air movement, aerial sustainment, casualty evacuation (CASEVAC) and combat search and rescue (CSAR) support functions. While some Army tactical airlift missions are supported by the C-23 Sherpa cargo airplane, most are conducted by CH-47 Chinook or UH-60 Blackhawk helicopters. Many operations are conducted hardstand to hardstand, meaning the aircraft is flying from one runway to another. As such, a large percentage of these functions could be conducted with fixed-wing aircraft. Acquiring, integrating and operating a larger number of airplanes to assume or supplement existing helicopter missions could be a more capable, flexible, efficient and economical solution to meeting Army airlift mission requirements.

#### Primary Research Question

Could the United States Army better meet intra-theater tactical airlift requirements and save a significant amount of defense funds by acquiring and employing a greater number of fixed-wing aircraft to fly previously designated rotary-wing missions?

#### Secondary Research Questions

To answer the primary research question, four secondary questions must be addressed. First, what tactical airlift gaps exist now (and are projected) on the modern battlefield? Second, what is being done to meet Army tactical airlift requirements? Third, what prevents the United States Army from operating a larger fleet comprised of light and medium fixed-wing cargo aircraft designed to conduct intra-theater tactical airlift? Fourth, does it make sense for the Army to have a greater organic airlift capability like JCA?

### Significance

This study aims to identify benefits gained by flying the C-27J Spartan with respect to capability, flexibility, efficiency and cost. The large battlespace in Iraq and Afghanistan has exposed an existing time and distance “airlift gap” within the Department of Defense that cannot be met with Army CH-47 Chinook and UH-60 Blackhawk helicopters due to operational range and high altitude limitations. Similarly, Air Force C-130 Hercules and C-17 Globemaster III airplanes are generally too large due to runway take-off requirements in excess of 3000 feet (Knight 2007, 2). The capability of operating on shorter runways almost doubles the number of suitable airfields that the joint force can utilize worldwide (Initial Capabilities Document 2005, 7). Army helicopters and Air Force large airlifters cost a significant amount of defense funds to operate, no matter what size the cargo load is. This study will identify the existing intra-theater “airlift gap” and provide recommendations for airlift solutions that support evolving Army needs.

### Assumptions

This study makes four noteworthy assumptions. First, both the Department of Defense and the Army are receptive to expanding the roles and functions of fixed-wing aircraft to better meet Army requirements with commercial off the shelf (COTS) civilian aircraft or tested aircraft within the military inventory. Second, the plan for JCA to replace all C-23 Sherpa and some C-12 and C-26 aircraft in the USAR and Army National Guard will remain unchanged. Third, Army Transformation will allow the JCA to grow beyond the ranks of the USAR and Army National Guard and be fielded to the Active Duty Army in general purpose units. Finally, the Army will retain an organic



intra-theater mission beyond the near-term requirements related to the wars in Iraq and Afghanistan.

### Definitions

Listed below are some key terms that are relevant to this study. These are doctrinal terms taken from Army, Air Force and joint publications that are commonly utilized when describing the various missions, functions and concepts associated with military airlift. In the interest of clarity and brevity, a general definition is provided in order to assist the reader in understanding the concepts and analysis presented in this study. The following key terms will be utilized as indicated:

Aerial Delivery Distribution: Aerial delivery methods including airdrop, airland and sling-load operations. Airdrop and airland distribution are joint (Army and Air Force) operations that require large fixed-wing aircraft; sling-load operations are usually unilateral using rotary-wing aircraft (FM 4-20.41 2003, 2-1).

Aeromedical Evacuation (AE): The movement of patients under medical supervision to and between medical treatment facilities by air transportation (JP 3-17 2002, IV-4). AE is also known as Medical Evacuation (MEDEVAC) (FM 1-100 1997, 2-10).

Airdrop: The unloading of personnel or materiel from aircraft in flight. Techniques: free drop, free fall, high velocity drop and low velocity drop (FM 4-20.41 2003, 2-2).

Airland: The preferred method of aerial delivery. Moved by air and disembarked, or unloaded, after the aircraft has landed or while a helicopter is hovering

(FM 4-20.41 2003, 4-1). Four concepts of employing airland are: hub and spoke, direct delivery, lily pad and air bridge operations.

Air Movement Operations: Operations that are conducted to reposition units, personnel, supplies, equipment, and other critical combat elements in support of current and/or future operations. These operations include both airdrops and air landings (FM 1-100 1997, 2-8).

Aerial Sustainment Operations: The movement of equipment, material, supplies and personnel by utility, cargo, and fixed-wing assets for operations other than air assault and combat support. Missions include intra-theater airlift; administrative relocation of troops and nonmilitary personnel; and administrative relocation of equipment, material, and supplies (FM 1-100 1997, 2-10).

Combat Employment and Sustainment: Combat employment missions allow a commander to insert surface forces directly and quickly into battle and to sustain combat operations. Combat sustainment missions may consist of reinforcement of front-line forces engaged with an adversary (JP 3-17 2002, IV-4).

Casualty Evacuation (CASEVAC): The battlefield pickup and movement of casualties; evacuation of casualties to initial treatment facilities; and subsequent movement of casualties to treatment facilities within the combat zone from forward locations to a designated collection or treatment facility (FM 1-100 1997, 2-10).

Focused Logistics: The fusion of information, logistics and transportation technologies to provide rapid crisis response, to track and shift assets even while en route, and to deliver tailored logistics packages and sustainment directly at the strategic, operational, and tactical level of operations (Joint Vision 2020 2008, 24).

Full Spectrum Operations (FSO): The Army's operational concept that requires the service to be ready to conduct simultaneous offense, defense, and stability or civil support operations anywhere along the spectrum of conflict, from General War to Stable Peace (FM 3-0 2008, 3-1).

Intra-Theater Airlift: Airlift conducted within a theater of operations. Provides airlift for the air movement of personnel and materiel within a geographic combatant commander's area of responsibility (JP 3-17 2002, IV-1).

Inter-Theater Airlift: Airlift conducted between separate theaters of operations. Provides the air bridge linking a theater to other theaters and theaters to the Continental United States (CONUS) (JP 3-17 2002, IV-2).

Operational Support Airlift (OSA): Operational support airlift (OSA) missions are movements of high-priority passengers and cargo with time, place, or mission-sensitive requirements. OSA aircraft are those fixed-wing aircraft acquired and/or retained exclusively for OSA missions, as well as any other Department of Defense-owned or controlled aircraft, fixed- or rotary-wing, used for OSA purposes (JP 3-17 2002, IV-6).

Passenger and Cargo Movement: Movement requirements filled through regularly scheduled channel missions over fixed route structures with personnel and cargo capacity available to all customers (JP 3-17 2002, IV-6).

Payload: The sum of the weight of passengers and cargo that an aircraft can carry (JP 1-02 2008, 413). There is an expected trade-off between the payload weight and the range of an aircraft. For longer flights, payload is often sacrificed for fuel.

Sling-Load: Transporting cargo that is attached to a helicopter with a strap, chain or other material and is hoisted, lowered or suspended (4-20.197 2006, 1-1).

### Limitations

Public information acquired through the Combined Arms Research Library (CARL) and the United States Army Aviation Center (USAAVC) were the primary sources of information. Limited interviews within the Army lift community also contributed. Although this study relied heavily on open-source data for aircraft purchase and operating costs, proprietary data was not utilized. The study made use of performance and capacity data obtained from Jane's All the World's Aircraft and various aircraft manufacturer websites. Due to the small size of the community, little doctrine exists on Army fixed-wing cargo aircraft conducting tactical airlift operations. The doctrine that does exist primarily resides in the C-23 Sherpa community in the form of unit products. Few databases exist in the United States Army regarding the employment and sustainment of fixed-wing airlifters. Most of the combat airlift data associated with the Global War on Terrorism (GWOT) is classified due to the nature of the missions and therefore tonnage requirements for Operations Enduring Freedom and Iraqi Freedom will not be discussed.

### Delimitations

The focus of this study was aimed at Army use of fixed-wing cargo aircraft to better to meet service intra-theater airlift requirements and ease the strain on the rotary-wing fleet. The study reviewed data to compare capability, flexibility, efficiency and cost but the study did not conduct a doctrine, operations, training, materiel, leadership and

facilities (DOTMLPF) analysis. While there are other aircraft in the Army inventory, the study limited performance and capability comparisons to the C-27J, C-23B, UH-60 and CH-47. The individual series of aircraft will only be delineated when it is applicable to the point being made. Purchase cost comparisons of the C-23B were not included because the aircraft is being retired from the Army inventory.

### Conclusion

This study explores the logic behind expanding Army fixed-wing aircraft roles and missions. Acquiring, integrating and operating a larger number of light cargo airplanes to assume or supplement existing utility and cargo helicopter missions is a more capable, flexible, efficient and economical solution to meeting Army intra-theater airlift mission requirements. Chapter 2 examines the various sources of published literature relevant to the scope of this study.

## CHAPTER 2

### LITERATURE REVIEW

#### Introduction

The Literature Review is critical examination of the existing information significant to the field of military tactical airlift but limited in scope to intra-theater operations conducted by the United States Army and Air Force. The aim was to research why acquiring, integrating and operating a larger number of light cargo airplanes to assume or supplement existing utility and cargo helicopter missions is a more capable, flexible, efficient and economical solution to meeting Army intra-theater airlift mission requirements. This review evaluated existing information, illustrated the various perspectives of the different sources, and then explained its significance. Five primary categories of literature are relevant: (1) service and joint doctrine; (2) government and military reports; (3) historical documents; (4) professional journals and newspaper publications; and (5) text and reference books. Each piece of literature noted was analyzed and assessed to ensure it was relevant, appropriate and useful with respect to the scope of this study. After a discussion of the five categories, this chapter presents a summary of trends, conflicts and gaps between the various sources of information and then discusses the significance of the study.

#### Service and Joint Doctrine

This study conducted a qualitative review of Army, Air Force and Joint doctrine to better understand how the JCA will be employed to support military, interagency and

civil support operations while conducting the Range of Military Operations (ROMO) and Full Spectrum Operations (FSO).

### Army Doctrine

A review of Army doctrine provided insight as to how the service views the nature of operations and the fundamentals by which Army forces conduct and support FSO. *Army Doctrine* is a body of thought on how Army forces intend to operate as an integral part of a joint force (FM 3-0 2008, D-1). Doctrine in this context is a guide to action and combines history, an understanding of the current operational environment and assumptions about future conditions to help leaders think about how to best accomplish missions (FM 3-0 2008, D-1). Nine sources of Army doctrine were examined with the focus directed at how the JCA will be employed in support of Army forces.

FM 3-0, *Operations*, institutionalizes how the Army conducts the four components of FSO: offense, defense, stability and civil support operations. As one of two capstone doctrinal publications for the Army, FM 3-0 is a principle driver for changes and modifications to operations and training issues required by modularity. FM 3-0 provides guidance for and directly affects organizations, training, leader development, human resource policies, facilities management, logistics support, and materiel development. Furthermore, this publication overarches all other 3-series publications for the Army.

FM 3-90.6, *The Brigade Combat Team*, provides guidance for the three types of Brigade Combat Teams (BCT) in the Army. The BCT is a fixed organization and the Army's basic tactical maneuver unit. The BCT is the smallest organization that can be employed independently and is a key consumer of Army tactical airlift (rotary and fixed-

wing) while deployed. FM 3-90.6 reinforces the Army's commitment to employ expeditionary and modular forces in support of FSO.

FM 3-04.100, *Army Aviation Operations*, presents the doctrinal basics for the employment of aviation forces as an essential element of combat power (FM 3-04.100, V). This publication is over 12 years old but still has value with respect to providing guidance for the general employment of aviation forces. Though FM 3-04.100 makes little mention of Army fixed-wing aircraft employment, it still has application for this study due to information provided on CH-47 Chinook and UH-60 Blackhawk helicopter roles and missions.

FM 3-04.111, *Combat Aviation Brigades*, is a keystone document for Army Aviation; specifically for fighting and sustaining aviation brigade and task force formations in a deployed environment. FM 3-04.111 reinforces the fundamental principles found in FM 3-0, *Operations*. For the purpose of this study, FM 3-04.111 provides central guidance for aviation support missions in the Army like air movement, aerial sustainment, combat search and rescue (CSAR) and casualty evacuation (CASEVAC). The publication also provides guidance for unit organization, command and control (C2), maintenance support functions and operations in an asymmetric environment. FM 3-04.111 provides a brief overview of various Army rotary and fixed-wing aircraft. Brigade level publications like FM 3-90.6 and FM 3-04.111 demonstrate the Army's determination to have a unit of effort while integrating air and ground formations.

FM 3-04.613, *Utility and Cargo Fixed Wing Operations*, addresses the roles and functions of Army fixed-wing forces within ROMO and unified action. The manual



provides operational doctrine for command & control, organizations, planning and operations of Army fixed-wing forces. This manual incorporates various points from JP 3-0 *Joint Operations* and JP 4-0 *Sustainment* to ensure integration of Army fixed-wing forces into the Joint Force. FM 3-04.613 explains the task and purpose for cargo and utility fixed-wing aircraft conducting air movement of key personnel and mission-essential logistical support. FM 3-04.613 briefly discusses the various fixed-wing platforms in the Army inventory, and provides useful performance and capability data. The manual is relevant to this study because it explains how the fixed-wing fleet and emerging technologies will meet warfighting and peacetime airlift requirements. Furthermore, the manual says the Army is a large consumer of air transport for sustainment operations and Army fixed-wing aircraft can provide a solution for transport of critical supplies, materiel and personnel. FM 3-04.613 provides guidance for how Army fixed-wing aircraft will function in the future operational environment.

FM 3-04.118, *Army Fixed-Wing Operations*, is in draft form and appears to incorporate lessons learned from the GWOT as well as various points from JP 3-0 *Joint Operations* and JP 4-0 *Sustainment* with the intent to ensure joint force considerations by Army elements. This draft manual provides general guidance for Army Aviation forces employing fixed-wing aircraft. FM 3-04.118 (draft) provides broad guidance for missions and organization, C2 systems and procedures, employment and sustainment practices designed to support service, joint, interagency and multinational organizations. This manual is relevant to this study because it addresses current and projected Army fixed-wing roles and functions. The significance is in its brief discussion of airlift mission guidance for the Army's only cargo aircraft (the C-23 *Sherpa*) currently in use.

Additionally, FM 3-04.118 briefly discusses the various fixed-wing platforms in the Army inventory, and provides useful performance and capability data.

FM 3-04.113, *Utility and Cargo Helicopter Operations*, provides guidance for Army air assault and general support helicopter battalions. As a basis for air assault and general support helicopter doctrine, force design, materiel acquisition, and unit training, FM 3-04.113 is relevant because aside from doctrinal guidance in operational and sustainment practices, it provides procedural and technical data to be compared between CH-47 Chinook and UH-60 Blackhawk helicopters with cargo airplanes like the C-23 *Sherpa* and C-27J *Spartan*. The manual is also important because some JCA will be aligned under the General Support Aviation Battalion (GSAB) in a Theater Aviation Brigade (TAB) or Combat Aviation Brigade (CAB).

FM 4-20.41, *Aerial Delivery Distribution in the Theater of Operations*, describes how the Army conducts aerial delivery, airdrop, airland and sling-load operations. FM 4-20.41 explains the basic principles of aerial delivery doctrine and how the distribution of supplies will be affected by Army Transformation. The manual explains the advantages and disadvantages of aerial delivery operations and the various organizations that conduct airland and airdrop operations. FM 4-20.41 highlights new equipment and emerging technologies that will enhance aerial delivery capability. The manual is relevant to this study because the scope is limited to aerial delivery as it relates to ground force sustainment by Army and Joint aviation forces. Further, FM 4-20.41 explains how aerial distribution is a force multiplier and strengthens the capability, flexibility and agility of the Army supply distribution system.

## Air Force Doctrine

The Air Force provides unique warfighting capabilities and Air Mobility functions that are essential to joint operations conducted by the Army. AFDD 2-6, *Air Mobility Operations*, is the keystone manual for the Air Force airlift doctrine and provides guidance for air mobility organizations, command relationships and operational elements while employing air mobility forces across the range of air and space operations (AFDD 2-6, VII). AFDD 2-6 provides insight as to how the Air Force conducts the five basic missions of airlift: passenger and cargo movement, combat employment and sustainment, aeromedical evacuation, special operations support, and operational airlift support. AFPAM 10-1403 *Air Mobility Planning Factors* provided broad air mobility planning factors for peacetime and wartime operations for the various airlift missions. The pamphlet was designed to help service and joint planners build estimates with respect to air mobility requirements, and served as a guide to measure and compare airlift missions and aircraft. The pamphlet provided useful terms and definitions, formulas and planning factors that could serve as practical and functional means to examine aircraft capability, fleet capacity and cycle times.

## Joint Doctrine

In the strategic context, JP 3-0, *Joint Operations*, explains and discusses the fundamentals of joint operations for the United States armed forces. It is clearly the keystone document for the conduct of joint operations during ROMO in support of national security goals at home and abroad. JP 3-0 is relevant to this study because it reinforces the idea that joint forces must understand the strategic direction to have better unified action in execution and identifies six Joint Functions for air, ground and seaborne

forces. One of those functions is *Movement and Maneuver* in which airlift is an important facilitator and provider. Consequently, JP 3-0 provides overarching guidance for other publications like JP 3-17, *Air Mobility Operations*.

JP 3-17, *Joint Doctrine and Joint Tactics, Techniques and Procedures for Air Mobility Operations*, provides guidance for air mobility operations across ROMO. This publication explains basic air mobility mission sets and provides more specialized information regarding delivery concepts like airland and airdrop operations in support of ground forces. JP 3-17 provides guidance on the five basic missions of airlift: passenger and cargo movement, combat employment and sustainment, aeromedical evacuation, special operations support, and operational support airlift. JP 3-17 is doctrinally significant since it recognizes the Army as the largest consumer of airlift and specialized airlift functions must be provided by other services (JP 3-17, IV-6).

#### Government and Military Reports

This study conducted a qualitative and quantitative review of United States Government and military reports that pertained to the acquisition and employment of small airlifters. The scope of this effort was limited to collecting information on Short Takeoff and Landing (STOL) and Vertical Takeoff and Landing (VTOL) aircraft programs for the Army and Air Force. These reports are relevant because they provided the detailed background, facts, assumptions, potential options and recommended solutions to airlift problem sets germane to this study.

## Transformation and Modernization Documents

*The Joint Operating Environment 2008: Challenges for the Future Force* was released by the Department of Defense in 2008. The document provides guidance for future trends and implications for military and civilian leaders that will conduct joint, interagency, intergovernmental and multinational (JIIM) operations over the next twenty five years. This document is relevant to this study because it discusses the trends influencing global security and deployment implications for the joint force as it works with other organizations during ROMO.

*Joint Vision 2020* was released by the Department of Defense to present guidance for how the military services must be a joint force capable of full spectrum dominance by the year 2020. *Joint Vision 2020* builds on the foundations originally presented in *Joint Vision 2010* and confirms the direction of the ongoing transformational capabilities and emphasizes the importance of progressive experimentation, exercises, analysis, and conceptual thought. *Joint Vision 2020* is relevant to this study because it recognized the importance of technological and technical innovation to military operations that lead to changes in organization and doctrine for the betterment of the joint force. This document also illustrates how full spectrum dominance is achieved through the interdependent application of dominant maneuver, precision engagement, focused logistics and full dimensional protection. For the purposes of this study, operational concepts such as “dominant maneuver” and “focused logistics” directly relate to airlift and aerial distribution of ground forces. Furthermore, this document emphasizes the importance of interoperability with joint, interagency, international and multinational partners while the military performs ROMO.

Army Transformation describes the concept and vision for the United States Army to transform and modernize from a Cold War structured organization to one best prepared to operation across the full spectrum of conflict as an expeditionary and modular brigade-centric force. “Transformation” is a comprehensive term for the integration of new concepts, organizations, and technology; all of which strongly influences how the service trains and operates (doctrine) and how forces are generated (DOTMLPF). Details of Army transformation and modernization programs were available by examining four major documents including: the *Army Transformation Roadmap (ATR)*, the *Army Modernization Plan (AMP)*, the *Army Campaign Plan (ACP)*, and the *Army Aviation Transformation Plan (AATP)*. This study reviewed these sources to collect information on what Army transformation and modernization strategies exist, and how they support the service’s objectives to meet current and future challenges with respect to airlift support to an expeditionary and modular Army.

#### Army Aviation Future Concept Documents

The Concept Capability Plan (CCP) *Aviation Operations 2015-2024* published in 2008 describes how Army Aviation will support the modular force in the future and identifies the required capabilities needed to accomplish Joint and Army functional concept objectives. The CCP assists in the development of an aviation focused capabilities-based assessment and is relevant to this study because it focuses on eight Aviation critical capabilities within the six Joint functional concept areas and six Army functional concept areas (core missions) during full-spectrum operations. This study reviewed all core mission sets but closely examined three of the eight Aviation critical capabilities because they are relevant to airlift operations (Vertical Maneuver, Air

Movement and Aviation Sustainment). The CCD acknowledged the need for STOL aircraft for the evolving Future Force.

The 2008 Functional Area Analysis (FAA) *Army Aviation Operations Capabilities Based Assessment (CBA) 2015-2024* continues the work of the CCP *Aviation Operations 2015-2024*. The FAA is a single-source reference for Army Aviation mission areas and summarizes the tasks and standards necessary to execute future concepts from the CCP. The FAA is significant to this study because it provides essential information on the Army's methodology and analysis while conducting a capability-to-task approach for the eight Aviation critical capabilities; specifically Vertical Maneuver, Air Movement and Aviation Sustainment.

#### Congressional Research Service Reports

This study reviewed three Congressional Research Service (CRS) Reports for Congress and one Congressional Hearing statement which spanned the period of 2001 to 2007. These documents provided an understanding of what is being reported to the United States Congress with respect to Army Transformation and modernization efforts. The study paid particular attention to some special topics associated with the JCA Program like procurement and fielding considerations, "roles and missions" concerns and Department of Defense efforts to address the "airlift gap" during ROMO and FSO.

CRS Report "Army Transformation: Overview and Issues for Congress" described that the Army began the transformation process to build a strategically responsive ground force that dominates the full spectrum of conflict. The report details conceptually why and how the Army must transform from a Legacy Force with existing heavy systems from the Cold War, to a medium-weight Interim Force with current

technology, to an eventual Objective Force that is based on the lighter and more technologically advanced Future Combat System (FCS) that is based on 25 technologies (later adjusted and published in the Army Modernization Strategy series). The report said that the Interim Force will largely utilize COTS systems in order to save on cost and mitigate risk. This is relevant to this study because the JCA is a commercial-off-the-shelf (COTS) aircraft purchased under a joint acquisition program between the Army and Air Force. The report acknowledges the stress placed upon air mobility assets and systems in the past and emphasized the Army must be prepared if called upon to conduct FSO. The report emphasized Army brigades must be lighter, digitized and networked so that they can deploy within a five day period as an independent formation that is modular and expeditionary. It is interesting to note that the report was published in April 2001, some five months before the terrorist attacks on 9/11.

CRS Report “US Army Modular Redesign” informed Congress that the United States Army underwent the most significant redesign in fifty years. At the time the report was published in May of 2006, the Army was becoming the *Army Modular Force (AMF)* and was converting 10 Active Component divisions into 42 to 43 modular BCTs by the end of FY 2007. Army National Guard and Reserve division transformation details had not been released at the time of the report. Important to this study is the fact that those smaller expeditionary units would still contain a significant amount of troops, systems, equipment and supplies that must be transported and sustained.

The Congressional Hearing statement “Hearing on Air Force and Army Airlift and Aerial Refueling Fixed Wing Programs” detailed to the House Armed Services Committee and Air & Land Forces Sub-Committee deliberators regarding the status of



existing and emerging fixed-wing aircraft programs within the two services. The hearing specifically addressed the JCA program and the increasing need for “short-range” airlift. Based on the 2006 Quadrennial Defense Review and other studies, the report suggests that the US military will likely continue to operate from geographically distant locations while conducting a wide range of operations. While this report was published in March 2007 prior to the announcement of the C-27J winning the JCA competition, it is significant that the Department of Defense was still considering other platforms within the inventory for JCA such as the C-130J and CV-22. The report further explained that the Army preferred a smaller two-engine aircraft, while the Air Force was informally favoring the larger four-engine C-130J due to compatibility and interoperability. The report also suggested that an Unmanned Aerial Vehicle (UAV) is not out of the question for the future; especially for smaller valuable payloads like blood plasma, night-vision devices, ammunition and communications equipment.

“Military Airlift: Joint Cargo Aircraft”, another CRS Report, provided the United States Congress with a background, overview and status of the JCA program. The report was published in December 2007 and described the JCA program as a joint effort to meet Army and Air Force intra-theater airlift requirements. This report is significant because it addresses the issues that align with the scope of this study and highlights airlift challenges within the Department of Defense. The report provided a synopsis of the historical, current and projected need for a small airlifter to fill the airlift “gap” for the Air Force and Army. The report outlined how JCA will meet intra-theater airlift requirements in support of a more modular and expeditionary force employed to support the full-spectrum of conflict. The report explained the perspective of each service in the

“roles and missions” debate, and how each service would employ JCA in support of their organic mission set and in a joint capacity. This report makes useful performance and capability comparisons between Army fixed-wing and rotary-wing transports, and justification for why the Army needs the C-27J Spartan to replace the C-23 Sherpa and augment the CH-47 Chinook fleets.

#### Future Cargo Aircraft and Joint Cargo Aircraft Documents and Reports

Various Army reports provide insight to the procurement and development of a common medium lift, fixed-wing cargo aircraft that has evolved from the FCA program to the current JCA program. Examining an Initial Capabilities Document (ICD) and Capability Development Document (CDD) provided valuable information regarding the early justification for the FCA/JCA program from an Army perspective.

Published in 2005, “Capability Development Document (CDD) for the Future Cargo Aircraft” says that Army fixed-wing cargo aircraft will become a central and vital part of the Joint Force and will assist the Joint Force Commander (JFC) in achieving full-spectrum dominance through focused logistics and aerial distribution. The CDD acknowledges that forces dispersed across a noncontiguous battlespace have overextended the logistical reach and strained the Army’s rotary-wing fleet. Additionally, the CDD stipulates that the current Army fixed-wing fleet is inadequate to meet the needs of the current and future force because it was not based on wartime requirements. The document acknowledges the need for an interoperable aircraft that can more quickly trans-load supplies or equipment with other Army or joint aircraft.

Also published in 2005, “Initial Capabilities Document (ICD) for Aerial Sustainment Capability” summarizes the need for FCA/JCA by explaining modular force requirements in the contemporary operating environment. The ICD report illustrates that the BCT is the foundational unit for the Interim and Future Force structure. The report characterized the BCT as a combat arms unit that has the capacity to deploy in five days and immediately start combat operations in a non-contiguous battlefield with an expansive objective area as large as 400 kilometers. The report argues that the BCT is self-sustaining for up to seventy two hours and must be resupplied every three to seven days. In short, a BCT will often require TS/MC aerial delivery support from an Intermediate Supply Base (ISB) to a Forward Operating Base (FOB), and perhaps to an isolated forward location. Further, the ICD identifies through a Functional Solution and DOTMLPF analysis, an airlift gap for which JCA is a solution to mitigate the maintenance and operational strain imposed on the CH-47 Chinook and UH-60 Blackhawk fleet. The ICD is relevant to this study because it presents ideas and conducts an analysis for solutions to sustain the modular and expeditionary BCT by an effective and efficient medium cargo airplane instead of a medium or heavy lift helicopter. The ICD also identified several Army Aviation mission sets the cargo airplane should assume.

### Historical Documents

There was a wide range of historical information available regarding the employment of Army and Air Force aviation assets during past conflicts. Through a qualitative review of historical examples from the end of World War II through the present, this study examined various formal agreements between the Army and Air Force that shaped the way each supported service specific and Department of Defense

requirements. Historical documents that influenced how the United States structured aviation forces among the military services and designated roles and missions were examined as well. Each document influenced how aviation forces were manned, trained and equipped to meet the needs of our nation. Specifically, the study examined information resources that influenced the way the Army tailored its aviation forces to support service mission sets.

### Professional Journals, Magazine and Publications

Professional journals, magazines and publications are often used to circulate ideas and concepts within similar fields and organizations. This study conducted a qualitative review of journals, magazines and publications. Many were excellent sources for concise and up-to-date information. Research was focused on small airlifter programs for the Army and Air Force being reported by the professional and military aviation communities. There were a number of journals, magazines and publications dedicated to United States military Air Power and Aviation that regularly discuss missions, roles and capabilities of the Army and Air Force. Articles contained in these sources contained a plethora of information ranging from fact to opinion, so many times the information gained was a starting point for other resources. Articles like “First C-27Js Delivered to the Army” published by the *Army Times*, “Army receives full funding for Joint Cargo Aircraft” published in *The Hill*, and “Army, AF Announce Joint Cargo Aircraft Program” published by *The Army News Service*, provided information of the program regarding funding and fielding. The articles reported that the Army in particular has been adamant about buying a smaller cargo aircraft that can go deep into the battlefield to deliver needed supplies to troops. The articles also highlighted some of the challenges associated

with the program, mainly how the budget was allocated in FY 2008 between the Army and Air Force. Various articles in *Aviation Week* including “SOF to Convert One C-27J to Gunship Lite” provided insight to purchase cost of the aircraft and some alternate mission sets that the Department of Defense is considering.

### Literature

No books were reviewed that were specifically written about the modern employment of Army airlifters in support of FSO and ROMO; they remain to be written. However, a number of sources provided valuable technical data on Army aircraft and historical perspectives that shaped how the service organized, trained and equipped the aviation forces since 1947.

*American Military Aircraft* is a comprehensive guide to over 200 military aircraft in the Department of Defense inventory. The book covered various cargo airplanes and helicopters in detail and featured developmental, specifications and performance data. This information enabled comparisons of performance and haul capacity data between the various aircraft. Much of the information provided insight to whether or not the platforms were interoperable with existing aircraft within the United States military and evolving technologies. *US Army Aircraft Since 1947* was a comprehensive book that provided valuable information on the various helicopters and airplanes tested and utilized by the Army. The book included information regarding aircraft serials, markings, weapon systems, operational history and technical data. Another book worth mentioning in this literature review is *US Army Aviation Color Schemes and Markings, 1942 To the Present*. Though the book had limited value for examining technical specifications or

performance data, it was an excellent resource for seeing and understanding the large number of fixed-wing aircraft that have been and remain in the Army inventory.

There was a wide range of historical information available regarding the employment of Army and Air Force aviation assets during past conflicts and wars, especially Vietnam. *Interservice Rivalry And Air Power In Vietnam*, by Dr. Ian Horwood, was the most significant and provided a comprehensive explanation of the nature and levels of rivalry between the Army and Air Force leading up to and during the conflict. Horwood illustrates that from the very beginning of military aviation, the services have argued how airplanes should be developed and utilized, and which service should employ them. *Interservice Rivalry and Air Power in Vietnam* provided an explanation from an Army perspective of the key acts, service agreements, directives and memorandums since 1947 that largely shaped how the Army organized, trained and equipped to meet defined missions and roles with its organic aviation. The author explains the early visions of the Airmobile Army and names tactical airlift as a large source of friction between the Army and Air Force. The author argues that small airlifters like the C-7 Caribou were invaluable while providing accurate delivery of priority cargo loads to ground forces and extracting personnel from the combat zone.

#### Analysis of the Literature

Current and evolving Army and joint doctrine provides justification for employing JCA to conduct tactical intra-theater airlift now and in the future. Army Transformation is causing the service to develop and modernize into an expeditionary and modular brigade-centric force that can conduct operations across the full spectrum of conflict. Functional analysis indicates the need is significant for JCA to fill the “airlift

gap” by assuming or supplementing existing transport capabilities within the Army and Department of Defense. Army and joint efforts to evolve into an interoperable, multi-functional and complimentary force reinforce the idea that the services must embrace change and make adjustments to traditional roles and missions to meet the challenges of the future. While historically there has been friction between the services regarding roles and missions, there is a sense of cooperation and understanding between the Army and Air Force to get the job done. The Army will employ JCA to meet TS/MC airlift requirements, while the Air Force will integrate JCA into the Common-User system and compliment the Department of defense airmobility capability.

#### Gaps in the Record

Gaps in the record exist in the areas of JCA doctrine, unclassified fixed and rotary-wing movement statistics and detailed C-27J Spartan flying hour costs. Doctrine for operational employment of the JCA has not been published yet by the Army. The first C-27J was fielded to the Army National Guard in September 2008 for test and evaluation purposes, so the doctrine may be in draft form or remain to be written. For the Army, the Spartan is scheduled to have Initial Operating Capability (IOC) by FY 2010 and Full Operating Capability (FOC) by FY 2011. Though FM 3-04.118 (draft) provides broad guidance for Army fixed-wing missions and organization, C2 systems and procedures, employment and sustainment practices, it is assumed the C-27J Spartan will initially inherit C-23 Sherpa functions. Limited air movement and aerial sustainment data exists with respect to the number and types of missions/sorties preformed and the amount of cargo tonnage and passengers moved in support of Operations *Enduring Freedom* and *Iraqi Freedom*. Army fixed and rotary-wing airlift statistics and

information is collected and managed by the Combined Joint Task Force G3 Air in Afghanistan and Multi-National Corps-Iraq C3 Air in Iraq but is classified. There is limited open-source data on the operating and sustainment costs for the C-27A or C-27J Spartan. The Department of Defense and US Transportation Command publish hourly rates for most military fixed-wing and rotary-wing aircraft in the inventory but the C-27A or C-27J Spartan is not listed for FY 2009 or any year previous.

### Trends

There were seven principle trends identified during the literature review. First, the Army is committed to conducting FSO and supporting ROMO models. Second, the Army is in the midst of a significant transformation and modernization effort. Third, the Army is committed to conducting joint operations and employing interoperable equipment. Fourth, the Department of Defense is willing to adjust “roles and missions” to be prepared to fight current and future conflicts. Fifth, there is a time and distance “airlift gap” in the Department of Defense airlift capability that is not meeting the Army’s intra-theater airlift needs. Sixth, the Army currently uses the CH-47 Chinook and UH-60 Blackhawk helicopter to conduct Direct Support missions to transport TS/MC cargo and personnel. Finally, utilizing helicopters is costly, maintenance intensive and serves to reduce the availability of CH-47 Chinook and UH-60 Blackhawk for tactical missions.

### Significance of Thesis to Existing Literature

This study examined five categories of literature to provide a comprehensive understanding of existing information that is significant to the field of tactical intra-theater airlift. Each piece of literature noted was analyzed and assessed to ensure it was



relevant, appropriate and useful with respect to the scope of this study. While reviewing, comparing and analyzing the various sources of literature, this thesis identifies why the United States Army will better meet intra-theater tactical airlift requirements and save a significant amount of defense funds by employing fixed-wing aircraft (airplanes) to fly previously designated rotary-wing (helicopter) missions.

By examining doctrine, history, official reports, existing models, and evolving concepts for aerial sustainment of FSO, we can better understand why JCA will be a more flexible, responsive, faster, cheaper and efficient solution to meeting Army airlift mission requirements and enhance the capability of the Department of Defense. For the future, this thesis may provide insight as to why the Army should explore acquiring a single-engine cargo aircraft or unmanned aerial vehicle (UAV) to supplement the Army's fleet of light and medium helicopter transports.

### Conclusion

This Literature Review was a critical examination of the existing information significant to intra-theater operations and the military employment of small airlifters. After a discussion and explanation of the relevance of the five categories of literature, this chapter presented a summary of trends, conflicts and gaps between the various sources of information and then discussed the significance of the study. Chapter 2 examines the various sources of published literature relevant to the scope of this study.

## CHAPTER 3

### RESEARCH DESIGN

#### Introduction

The Army recognized the need for fixed-wing aviation assets to support intra-theater airlift requirements associated with current and future Army formations. The aim of the research was to answer why acquiring, integrating and operating a larger number of light cargo airplanes to assume or supplement existing utility and cargo helicopter missions is a more capable, flexible, efficient and economical solution to meeting Army intra-theater airlift mission requirements. But the question remains what are the appropriate fleet levels to better balance rotary-wing and fixed-wing employment to meet theater and tactical airlift requirements of the Army? Research methodology generally defines the actions of the research and how to measure data for the purpose of analysis. This chapter briefly describes the steps taken to obtain relevant information regarding Army utility and cargo helicopters and airplanes and the logic applied for analysis of those aviation platforms. This chapter then explains the strengths and weaknesses of the research methodology.

#### Steps Taken to Obtain Information

While searching for information and evaluating information sources, this study predominantly utilized resources of the US Army Combined Research Library (CARL) located at Fort Leavenworth as well as the Internet. Both proved to be useful while designing a research strategy and discovering diverse types of resources such as military doctrine, official reports, historical documents, media articles, books and internet sites.

Research of Army and Joint Doctrine was conducted by utilizing the web-based Army Publication Directorate (APD) and the Fort Leavenworth Master Library on the Command & General Staff College SharePoint portal. Research librarians at CARL provided copies of government and military reports, historical documents and books in both hardcopy and softcopy form. Open source web-based research provided access to on-line professional journals and newspaper publications. Research ranged from general to specific by reviewing wide-ranging background information first, and then utilizing more specialized resources. Research information and sources were sorted and aligned with the five literature categories as previously cited in Chapter 2. Technical information was translated into plain language format to the fullest extent possible for the purpose of explaining and applying logic of the appropriate problem sets.

### Collection and Analysis

There were three primary research objectives in this study that answered the primary and secondary research questions raised in Chapter 1. These research objectives were designed to gain a historical, doctrinal and technical understanding of why the Army currently has a rotary-wing centric aviation force and why it must restructure in order to meet evolving force requirements.

First, the research and analysis attempted to determine what has historically prevented the Army from acquiring and employing cargo airplanes and what is causing the service to utilize platforms like the C-27J Spartan. This study conducted a qualitative analysis of presidential executive orders, service agreements, memorandums and acts of legislation from 1947 to present. The study also examined resources that influenced the way the Army is organized, trained and equipped to support service

missions. Furthermore, the study examined resources that were the principle drivers of change and the basis for the Army and Air Force to share the intra-theater tactical airlift mission.

Second, the research and analysis attempted to determine why it is necessary for the Army to increase airlift capacity to better support FSO for the Interim and Future Force via a qualitative analysis of Army doctrine. Limited in scope to intra-theater tactical airlift, the study evaluated Army Aviation missions that require the use of utility and cargo helicopters and airplanes. The study compared various airframe capabilities with relevant mission sets and support tasks to identify fleet shortfalls.

Third, the research and analysis attempted to determine why the Army should employ a greater percentage of cargo airplanes as opposed to utility or cargo helicopters with respect to capability, flexibility, efficiency and cost. The Army's Logistic Planner 5.0 software was utilized to conduct a quantitative analysis of the various classes of supply required to support the Infantry Brigade Combat Team (IBCT), Stryker Brigade Combat Team (SBCT) and Heavy Brigade Combat Team (HBCT). The intent of examining this data was to gain an understanding of what the daily logistical requirements were for each type of BCT based on varying consumption rates, operating tempo and environments. The study then evaluated the various utility and cargo aircraft utilized by the United States Army to include C-27J Spartan and C-23 Sherpa airplanes and CH-47 Chinook and UH-60 Blackhawk helicopters. To assess airlift capability, the study conducted a quantitative analysis of cargo configurations, weights and performance data to compare lift capacity and fuel range in maximum and midrange payload configurations.

The study also utilized accepted airlift planning formulas contained in AFPAM 1-1403 to appraise theater capability and fleet capacity to determine mission flying times and missions required. Figure 2 *Airlift Formulas* show formulas to determine Cargo Sorties Required per Day (CSR/D), Theater Capability, and Fleet Capacity to compare Army aircraft. To evaluate flexibility, the study examined performance characteristics like max cruise airspeeds and cruise ceilings. To further evaluate flexibility for operating at unimproved airstrips and short airfields, the study conducted quantitative analysis of take-off and landing data.

## Airlift Formulas

**1. Number of Cargo Sorties Required Per Day (CSR/D)**

$$= \frac{\text{Requirement}}{\text{Average Payload Weight}}$$
  

**2. Fleet Capability (Short Tons Delivered in Theater Per Day)**

$$= \frac{\text{Average Payload Weight} \times \text{Number of Aircraft Available} \times \text{Utilization Rate}}{\text{Round Trip Flying Time}}$$

**NOTE:** Round Trip Flying Time (RTFT) is computed by dividing distance by block speed.

**3. Ton Mile Fleet Capacity (Million Ton Miles Per Day)**

$$= \frac{\text{Number of Aircraft Available} \times \text{Block Speed} \times \text{Average Payload Weight} \times \text{Utilization Rate} \times \text{Productivity Factor}}{1,000,000}$$

Figure 2. Airlift Formulas  
*Source:* Department of the Air Force, AFPAM 10-1043, *Air Mobility Planning Factors* (Washington, DC: Government Printing Office, 2003), 3-4.

To assess efficiency, the study conducted a qualitative analysis of transloadability and interoperability data. To appraise costs, the study conducted a quantitative analysis of purchase and operating expense rates and performance data. The study compared procurement costs for purchasing new airframes, but did not evaluate retrofit or refurbishment rates for existing airframes. The study compared operating and sustainment costs by evaluating standard flying hour expense rates.

### Strength and Weaknesses of Methodology

The strength of this research lies in understanding the doctrinal airlift requirements for the various types of Army brigades with generally known equipment and sustainment requirements. By citing that the C-27J Spartan will replace all C-23 Sherpas, C-26 Metroliners and some C-12 Hurons, effects to existing missions can be measured by comparing aircraft capabilities. Due to the number of variables involved in every airlift operation, the airlift planning formulas contained in AFPAM 1-1403 and utilized for this study provided approximations in the context of a realistic scenario to support FSO in a large and noncontiguous battlespace. The planning factors are not universally acceptable, but merely provided logical estimates while attempting to compare Army rotary-wing and fixed-wing aircraft. Understanding the utility and cargo mission sets of the CH-47 Chinook and UH-60 Blackhawk and aligning the C-27J Spartan with functional requirements that are overextended will be practical and constructive. The technical capacity of the various airlift platforms under varying atmospheric conditions (from insignificant to extreme) and operational pace can be measured and presented for straightforward understanding. Historical use of small airlifters in past conflicts can provide valuable lessons learned for employment of new

airlifters. The purchase and operating costs associated with employing utility and cargo aircraft can be generally projected by reviewing past trends and records of the appropriate aircraft. By applying rule sets for measures of performance to aircraft employment-based on efficiency and cost-based measures of effectiveness, operational systems can be developed and tailored on the needs of the mission.

Despite the strengths mentioned, there are several challenges that this thesis cannot address such as the specific airlift requirements of the evolving Future Force BCT with equipment that is in the process of being developed. The Army has agreed to initially purchase only fifty four C-27J aircraft under the Joint Cargo Aircraft program. The need for additional C-27J aircraft has not been published by the Army. The C-27J will be fielded and aligned under the Army's two Theater Aviation Battalions. The tactics, techniques and procedures for supporting the Interim and Future Force BCT with the C-27J and other fixed-wing platforms are in the development process. In short, the value of this platform in wartime in the contemporary operating environment is yet to be realized while it is still in the early stages of procurement and acquisition.

In conclusion, the research methodology of this study consists of three primary areas. First, a historical background recognizes the various influences on how the Army previously organized aviation forces to meet service requirements. Second, a doctrinal review identifies the operational need for increased airlift capacity of a modular and expeditionary Army. Third, a technical comparison of various aircraft will provide technical understanding with respect to capability, flexibility, efficiency and cost. The following two chapters provide insight of these three primary research areas.

## CHAPTER 4

### HISTORICAL BACKGROUND

#### Introduction

This thesis is primarily focused on the current and future employment of Army fixed-wing airlifters and the benefits gained from operating the C-27J Spartan. In order to better understand the context of small tactically-oriented cargo aircraft and their contribution to Army operations, this chapter reviews their historical influences and acknowledges early interservice rivalry to more recent cooperation. This chapter describes how the United States structured aviation forces among the military services and designate roles and missions based on acts of legislation, executive orders, formal service agreements, and secretariat directives and memorandums since 1947. The aim of this chapter is to outline briefly what historically prevented the Army from acquiring cargo airplanes and what eventually allowed the service to obtain the C-27J Spartan. First, is a discussion on why some of the cornerstone documents and service review boards influenced evolving roles and missions. Second, a review of the services peacetime and wartime employment of small airlifters from the Vietnam War to the more recent combat operations in Afghanistan and Iraq. Lastly, the chapter discusses the unity of effort and interservice cooperation associated with employment of the C-27J Spartan by the Army and Air Force under the JCA program.

#### Acts of Legislation and Formal Service Agreements

Since the very beginning of military aviation there has been a large amount of debate and frustration over the roles and missions of the military services and their



employment of aircraft. Multiple agreements between the Army and Air Force to define clearly roles and missions for conducting air operations and airlift since the end of World War II. These agreements clearly shaped how the Army manned, trained and equipped its aviation forces. A brief chronological listing of these agreements with impacts to Army Aviation acquisition and service is illustrated in Figure 3 and outlined in Appendix A of this thesis.



Figure 3. Key Acts, Agreements, Directives & Memorandums Since 1947.  
Source: Created by author.

Early acts of legislation and formal service agreements like the National Security Act of 1947 and Key West Agreement of 1948 were the cornerstones of an effort designed to reduce unnecessary redundancy and diminish inter-service rivalries by setting

clear boundaries on roles and missions. These acts were designed to define plainly these responsibilities while meeting the primary mission function and organic mission support requirements of the respective service. The Bradley-Vandenberg Agreement of 1949 and the Pace-Finletter Agreements of 1951 and 1952 sought to better define aviation combat support functions and battlefield dimensions between the Army and Air Force, while establishing weight criteria to limit the size and capability of Army aircraft. Extensive use of rotary-wing aircraft during the Korean War added a new dimension on the battlefield, especially while working in combination with fixed-wing aircraft.

From the end of the Korean War in 1953 to 1962, the teaming of fixed and rotary-wing aircraft as it applied to military doctrine was subsequently evaluated for transporting troops, equipment and supplies. The National Defense Reorganization Act of 1958 continued the effort to streamline roles and missions, but also empowered the Secretary of Defense to make decisions on research and development programs shared by two or more services (nationmaster.com 2009). The Williams and Powell Air Mobility Memoranda of 1962 directed that the Army should leverage aeronautical technologies and consider forming airmobile ground forces. This memorandum proposed the establishment of a board to assess the potential of aviation forces utilizing modern aircraft and applying airmobility concepts. In 1966 under the McConnell-Johnson Agreement, the Army and Air Force Chiefs of Staff agreed that the Army should keep and further develop helicopter capabilities, but barred the service from major fixed-wing airlift roles (Horwood 2006, 102). This agreement was essential in that it facilitated the growth of Army airmobility with helicopter capabilities, but essentially stunted the growth of tactical fixed-wing airlift. The Army wanted a small fixed-wing airlifter, but

the service needed the tactical mobility and firepower of the helicopter more. It would be over 20 years before the Army would acquire and operate light cargo airplanes again.

Later acts of legislation like the Goldwater-Nichols Department of Defense Reorganization Act of 1986 caused significant change in the manner in which the military organized, trained and equipped for service specific and joint operations. Goldwater-Nichols set the tone for modern employment of the US military and essentially made joint operations the norm. More recently, the Joint Cargo Aircraft Memorandum of Agreement of 2007 between the Army and Air Force acknowledges roles and missions while sharing the intra-theater airlift mission. The historical influences of these documents are substantial as the military services witnessed periods of early interservice rivalry to more recent cooperation.

### Evolving Doctrine and the Airmobile Concept

Competing service priorities, challenging budgets and debates over roles and missions has at times created a level of rivalry to the detriment of the Army's airlift needs. Within a few years of its creation, the Air Force became deeply involved in the development of strategic bombers, ballistic missiles and supersonic jet fighters needed to meet the growing threat presented by increasingly aggressive Soviet Union and her allies (Harding, 6). Though obviously necessary, the Air Force's attention on "high tech" aircraft and aviation programs nonetheless ensured that the Army did not receive the level of support and priority it deserved. Throughout the 1950s the Army pursued an expansion of aviation capabilities to address the perceived shortfall and provide better support organically. For example, the service grew its fleet of aircraft from 668 light airplanes and 57 helicopters in 1950 to over 5,000 aircraft in the inventory by 1960

(Tolson 1989, 7). The concept of *airmobility* emerged from a practical viewpoint that ground forces would be more effective on the battlefield with greater mobility and maneuverability. This concept envisages the use of aerial vehicles organic to the Army to assure the balance of mobility, firepower, command & control, intelligence and support (armyaviationmuseum.org 2009).

General James M. Gavin was a well-known officer who commanded the 82<sup>nd</sup> Airborne Division in World War II and was Army Chief of Research and Development in the 1950s. He believed that the conventional armed forces were being neglected by excessive reliance on nuclear weapons as a deterrent to war (Fowler 1990). In 1954, General Gavin wrote an influential article titled "Cavalry, and I Don't Mean Horses" in *Harper's Monthly*. The article suggested the use of highly mobile "Sky Cavalry" in lightweight armored vehicles and aircraft, influencing senior leaders within the Army to start considering airmobile-type operations.

In the early 1960s, the Army transformed its divisional formations under the Reorganization Objective Army Division (ROAD) program. This transformation effort demonstrated the need for the Army to examine aviation requirements and tactics. Two essential test and evaluation boards were primarily responsible for doctrinal advancement and provided direction for early "airmobility" concepts to be employed by the Army – the Rogers Board of 1960 and the Howze Board of 1962.

In 1960, the Army conducted a Tactical Mobility Requirements Board with the primary mission of upgrading and modernizing Army Aviation to meet tactical contingency requirements. Known as the "Rogers Board" because it was chaired by Lieutenant General Gordon B. Rogers, the findings were significant in that it made

recommendations for the Army to seek three general types of aircraft – observation, surveillance and transport – and modernize the aviation force structure (Tolson 1989, 8). The Rogers Board recommended procurement of the UH-1 “Huey” Iroquois and CH-47 Chinook helicopter which greatly improved mobility and maneuverability of Army ground forces. The report also provided essential guidance for development, procurement and personnel planning (Tolson 1989, 9).

Two years later in 1962, Secretary of Defense Robert McNamara directed that the Army conduct a study on improving the tactical mobility of the ground forces and exploit the potential of aeronautical technology (Tolson 1989, 18). This study would investigate the potential use of tactical aircraft as a means to transport and support troops. The board is known as the “Howze Board” because it was chaired by General Hamilton H. Howze, the Army’s first Director of Aviation. The most significant activity of the board involved investigation, testing and evaluation of the organizational and operational concepts of airmobility. The Howze Board made comparisons of conventional and airmobile forces throughout the evaluation. The findings and evaluations of field tests, war games, operations research, and visits to overseas combat theaters provided support to the final board report (Tolson 1989, 21).

The Howze Board concluded that force restructuring and aircraft modernization efforts would be necessary, which were consistent with the Department of Defense transformation objectives of the period (Horwood 2006, 43). The conversion of five conventional divisions to airmobile divisions would allow the Army to meet the intent of transforming from the former *massive retaliation* structure to one of *flexible response*. Modern fixed and rotary-wing aircraft could provide air mobility assets needed to

enhance the combat effectiveness of ground forces, a capability that the Air Force arguably lacked. Each of the airmobility divisions would operate 459 fixed and rotary-wing aircraft to enhance the combat effectiveness of ground forces, extensively reducing the need for ground vehicles and leveraging aircraft like the UH-1 Iroquois, CV-2 Caribous and CH-47 Chinook located in the forward Army area to deliver men, equipment, and supplies after Air Force aircraft had deposited them as far forward as possible (Tolson 1989, 23). As a result of the Howze Board recommendations, the Department of Defense created the 11<sup>th</sup> Airborne Division (Air Assault) as a provisional “airmobile” division to continue testing all aspects of rapid, aviation-based mobility until 1964.

The benefits of organic Army Aviation envisioned by the Rogers Board, evaluated by the Howze Board, and then validated by the 11<sup>th</sup> Airborne Division (Air Assault) forever changed the way the Army conducts land warfare. *Airmobility* evolved from concept to an essential battlefield application that provides greater mobility and maneuverability today for the ground force. The Vietnam War provided the Army with the opportunity to apply this new doctrine with great success (Harding 1997, 7). The mobility and support provided by organic Army aircraft allowed the service to move rapidly essential troops, equipment and supplies while dramatically lowering the need for slow and vulnerable ground transport.

### Small Airlifters in Vietnam

Small fixed-wing tactical airlifters have been regularly employed simultaneously by the Army and Air Force since the 1960s, although ownership has been controversial. During the early portion of the Vietnam War, the Army flew the CV-2 Caribou, while the

Air Force operated the C-123 Provider to perform troop transport and aerial delivery functions to remote and austere locations (Knight, 1). Army CV-2 Caribou aircraft performed so well in Vietnam that they became a source of inter-service tension. Much like the C-27J today, the short field characteristics and payload capacity of the CV-2 Caribou made it an ideal aircraft in Vietnam and the surrounding areas. As a twin-engine, STOL-capable cargo transport, the CV-2 complemented existing single-engine Army U-1 Otter and U-6 Beaver utility aircraft (Harding, 103).

CV-2 Caribou from the beginning exceeded the weight limit tacitly recognized by the Army and Air Force as the dividing line between their respective fixed-wing spheres of influence. The Air Force argued that the CV-2 could be even more valuable if they were integrated with C-123 and C-130 operations under Tactical Air Command (Harding, 104). Eventually, the Air Force successfully argued that the Army should relinquish ownership of the CV-2 Caribou and transfer the aircraft to the Air Force under the McConnell-Johnson Agreement of 1966. Signed by the Army Chief of Staff General Harold K. Johnson and his Air Force counterpart General John P. McConnell, the agreement formally recognized some compromises between the Army and Air Force. In return for an Air Force commitment to relinquish claims for operating helicopters designed to conduct intra-theater movement and resupply of Army forces, the service agreed to hand over its CV-2 Caribou airlift fleet. The Air Force also agreed to put an end to all previous weight restrictions on Army helicopters. By 1967, the Air Force flew the Caribou (now designated the C-7) in support of Army requirements for the remainder of the war. With funding scarce after the Vietnam War and a change on major combat

operations in Europe, the Air Force eventually retired the C-7 Caribou and the C-123 Provider without replacement (Knight, 1).

The effects of the McConnell-Johnson Agreement continued to be felt for over 40 years. While it clearly provided an opportunity for the Army to realize the unique mobility capabilities of the helicopter, the agreement restricted the Army from major fixed-wing airlift roles. Vietnam was indeed a testing ground for Army Aviation, and combat experience there led directly to the development of a wide range of systems that have since become standard for military aircraft (Harding, 8). Essentially, while the Army explored and capitalized on the new airmobility concept, the Army wanted a small fixed-wing airlifter, but the Army needed the helicopter more. As a result, Army Aviation evolved into a helicopter-centric force.

#### Small Airlifters for Alternate Roles

Almost 20 years after the McConnell-Johnson Agreement, the Army and Air Force were again operating light cargo airplanes. In 1984, the Air Force purchased eighteen C-23 Sherpa light cargo airplanes for the European Distribution System Aircraft (EDSA) program to transport time-sensitive cargo and supplies with Europe. The following year, the Army utilized the Shorts 330, a civilian version of the Sherpa, as a logistical support aircraft at the US Pacific Missile Range complex on the Kwajalein Atoll in the Marshall Islands. After the Air Force EDSA program ended in 1990, some Air Force C-23As were given to the US Forestry Service, while others were transferred to the Army Materiel Command and the Army National Guard. The Army further augmented this fleet by ordering an additional ten newly-built aircraft from the Shorts aircraft factory (Winchester 2005, 13). Recognizing the value of this light military



freighter, the Army National Guard eventually procured a total of forty four C-23B Sherpas, a slightly more capable version with improved engines, to support intra-theater airlift, airdrop, and aeromedical evacuation functions in support of state and federal missions. Operational experience with C-23 Sherpas proved that the aircraft had low maintenance costs and small fuel consumption in comparison to Army helicopters and larger Air Force transporters.

In 1991, the Air Force purchased ten C-27A Spartans under the Rapid-Response Intra-Theater Airlifter (RRITA) program to support operations around Howard AFB, Panama (Knight 2007, 2). Built for short takeoffs and landings, the C-27A Spartan, affectionately known as “Chuck” by its crews, flew to remote areas with dirt or grass landing strips. The Spartan participated in resupply functions associated with counter-drug operations and peacekeeping missions in Central and South America. After Howard AFB closed in 1999, the aircraft were retired from the Air Force inventory due to the high maintenance costs associated with operating such a small specialized fleet. Despite the Air Force’s discontinued use, it should be noted that the US State Department still operates the C-27A Spartan in support of counter-narcotics activities in South America.

#### Recognizing the Need for Small Airlifters

Combat operations associated with the Global War on Terrorism and national emergencies like Hurricane Katrina and Rita exposed a need for a small airlifter capable of conducting TS/MC air transport of troops, equipment and supplies. The wars in Iraq and Afghanistan have stressed Army helicopters and amplified the limitations of the C-23 Sherpa while conducting aerial delivery functions to remote and austere locations (Knight 2007, 2). Army C-23 aircrews performed admirably during Operation IRAQI

FREEDOM while attempting to meet the services intra-theater transport requirements. The C-23 provided an economic alternative for transporting up to 20 troops or 5000 lbs of cargo. Unfortunately the aircraft proved to be inadequate in wartime due to the cargo capacity and performance limitations.

In 2004, the Defense Department began to consider options to meet Army intra-theater airlift requirements after the service cited a need for more maneuver, movement and sustainment capability. The Army intended to retire less capable fixed-wing aircraft in its inventory like the C-23 Sherpa and purchase a small airlifter with greater performance in altitude and STOL capability. This airlifter would reduce the workload on Army helicopters like the CH-47 Chinook and UH-60 Blackhawk that were conducting the majority of TS/MC transport functions, both at high costs and reduction in service-life. In 2005, the Army received approval by the Department of Defense to proceed with the Future Cargo Aircraft (FCA) program. Also in 2005, the Air Force expressed a need for a small airlifter and proposed development of the Light Cargo Aircraft (LCA) program (Knight 2007, 2). In 2006, the Defense Department recognized the similarities of the Army and Air Force small air-lifter programs and merged FCA and LCA into the JCA program with the Army as program lead for both services.

In 2007, the C-27J Spartan, a vastly improved version of the C-27A, won the JCA competition and cooperation between the Army and Air Force began immediately. That same year, Army Vice Chief of Staff General Richard Cody and Air Force Vice Chief of Staff General John D.W. Corley signed the JCA Memorandum of Agreement which acknowledged the merging of the programs and outlined the way ahead. Specific issues addressed included roles and missions, command and control, sustainment, doctrine,

standardization and training, service responsibilities and significant program milestones. In this memorandum, the services agreed that the Army will operate the JCA in a service organic airlift role of *direct support* and the Air Force will incorporate the JCA into the common user airlift role of *general support*. The C-27J will provide the Army with a new fixed-wing transport aircraft capable of performing rapid-response intra-theater airlift missions as well as medical evacuation and airdrop delivery.

### Unity of Effort and Interservice Cooperation

In January of 2009, the Department of Defense formally assessed and aligned Army and Air Force service responsibilities for conducting intra-theater airlift operations in direct support and general support roles. The 2009 Quadrennial Roles and Missions (QRM) report stipulated that the Army and Air Force will share the intra-theater mission and the C-27J will be assigned to both services.

Airlift operations performed within a theater span the traditional division between “general support,” which is normally provided for the joint force by an Air Force component commander through a common-user airlift service, and “direct support” conducted by all Service component commanders employing their Services’ organic airlift assets. At the conclusion of the QRM, the Department determined Service responsibilities for intra-theater airlift operations are appropriately aligned, and the option that provided the most value to the joint force was to assign the C-27J to both the Air Force and Army. However, based on lessons learned from recent operations, there are areas for improvement. By changing internal policy, updating doctrine, and maturing concepts of operations to better reflect our intra-theater airlift vision, we will improve effectiveness, increase joint synergy and minimize duplication of effort for this mission. (Quadrennial Roles and Missions Report 2009, 19)

The alignment of airlift by service and mission support role is significant because it illustrates that the Defense Department has recognized the lessons learned from recent combat and stability operations and have reshaped the vision for future employment of intra-theater airlift. This realignment is also significant because it demonstrates the

Department of Defense willingness to adjust “roles and missions” to support FSO and ROMO. Without a doubt, current and future joint operations will require more effective and efficient airlift due to the expanded nature of conflict outlined by FSO and longer lines of communications illustrated in recent operations in Iraq and Afghanistan.

### Conclusion

Army Aviation has evolved from a small and ill-equipped liaison and battlefield observation capability into a highly maneuverable and lethal force that is capable of covering the spectrum of combined arms maneuver and support operations. The primary mission of Army Aviation has always been to fight the land battle and support ground operations (FM 1-100 1997, 1-3). Specific to theater aerial distribution of cargo and personnel, it appears the Army and the Air Force are entering a period of airlift cooperation. The Army currently finds itself in a period of transformation to meet the needs of a more mobile and maneuverable force, much like the service experienced while developing airmobile concepts in the 1950s and 1960s. The C-27J will be employed by both services in a manner that demonstrates a unified effort to provide direct and general airlift support to ground forces in wartime and relief efforts in peacetime. The employment of the CV-2 Caribou in Vietnam and the C-23 Sherpa in Iraq serve as successful examples that prove small airlifters are combat multipliers and fill the intra-theater function for the United States military. For the Army, the C-27J Spartan will provide greater airlift capacity than the C-23 Sherpa and will effectively and efficiently supplement or replace existing intra-theater airlift roles performed by Army cargo and utility helicopters like the CH-47 Chinook and UH-60 Blackhawk. The question remains whether or not if the initial estimate of fifty four Army C-27J Spartans is sufficient

enough to fulfill Army “service organic airlift” requirements. Whereas this chapter reviewed the historical influences and acknowledged early interservice rivalry to more recent cooperation, the next chapter will elaborate on how airlifters will continue to contribute to Army operations now and in the future.

## CHAPTER 5

### FINDINGS AND RESULTS

#### Introduction

It makes operational and economical sense for the United States Army to have a greater organic fixed-wing airlift capability to fill a time and distance “airlift gap” and improve the service’s ability to conduct intra-theater airlift. The Army could effectively support more intra-theater tactical airlift mission requirements and save a significant amount of defense funds by acquiring and employing a greater number of airplanes to fly previously designated helicopter missions. The chapter will discuss why acquiring, integrating and operating a larger number of airplanes to assume or supplement existing helicopter missions could be a more capable, flexible, economical and efficient solution to meeting Army airlift mission requirements.

First, the chapter briefly explains some of the difficulties the Army is experiencing while providing service-organic airlift in support of current operations and how the Department of Defense is adjusting to meet future challenges. Second, the chapter provides an overview of the C-27J Spartan under the JCA program; specifically its capabilities and limitations. Third, the chapter illustrates why it is necessary for the Army to increase airlift capacity to better support FSO for the Interim and Future Force. Finally, the chapter demonstrates through capability, efficiency, flexibility, and cost comparison, why the Army should employ a greater percentage of medium cargo airplanes.

### The Need for More Intra-Theater Airlift

The United States Army is the world's premier ground force that is capable of conducting FSO with JIIM partners. To meet current and future challenges, the Army is in the final stages of transforming to an expeditionary and modular force that centers its combat capability on the BCT. These brigades have the capability to be deployed independently within five days of notification and immediately begin operations upon entry into a theater of operations in a noncontiguous, expansive battlespace. There are currently three types of BCTs ranging from light infantry to heavy mechanized force. As designed under Army doctrine, each is equipped to sustain itself for up to three days, and then must receive resupply every three to seven days in order to continue operations (Initial Capabilities Document 2005, 11). Without consistent logistical support, the BCT expeditionary concept would not be possible because the force needs agile mobility.

To meet the priority aerial delivery needs associated with these brigades, the Army conducts service-organic airlift in the form of air movement, aerial sustainment and casualty/medical evacuation with medium lift helicopters and some airplanes. Currently, the CH-47 Chinook and UH-60 Blackhawk helicopter conduct the majority of aerial movement of TS/MC payloads, including personnel, equipment, and supplies (Capability Development Document 2005, 2). While this accomplishes the tasks, it does so at high operating costs and with significant impact on airframe service life. Of immediate importance, the extended use of these rotary-wing assets to meet sustainment needs requires a robust support structure and reduces availability for tactical support to maneuver units. Currently, the C-23 Sherpa is the Army's only cargo airplane. Though the aircraft has performed admirably during recent combat operations and national

emergencies, the limited performance and cargo capacity of the Sherpa prohibit Army fixed-wing aircraft from performing a greater percentage of effective airlift to forward, tactical locations.

Despite the Army's focus on rotary-wing aviation, military cargo and utility helicopters are more expensive to purchase and operate, and have limited speed and range in comparison to airplanes that carry similar cargo loads. Recently, the Army and Air Force selected the C-27J Spartan under the JCA program, a joint endeavor led by the Army to gain more intra-theater airlift capability. While the Air Force plans to incorporate the JCA into the existing common-user airlift system, the Army intends to utilize the platform to transport TS/MC cargo, supplies and personnel while conducting air movement, aerial sustainment and CASEVAC missions. To this end, the Army will purchase fifty four C-27J Spartans from FY 2008 to 2013, and will utilize the aircraft well into the 21st century.

The Department of Defense is making educated and progressive adjustments to the roles and missions of the military services so that they will work more effectively as an interoperable Joint Force. Defense Department guidance and directives are causing adjustments in joint and Army service doctrine to facilitate the military's capacity to seamlessly operate across the spectrum of conflict. Concurrently, the Army has made doctrinal changes to make possible the services ability to conduct FSO. Transformation and modernization efforts, coupled with emerging doctrine and increased mobility requirements for the BCT, indicate a greater need and capability for conducting intra-theater airlift.



Army helicopters like the CH-47 Chinook and UH-60 Blackhawk and cargo airplanes like the C-27J Spartan are combat multipliers. As such, these aircraft are always in demand. If the Army is to maintain dominance during FSO, the service must optimally balance and leverage its fleet of helicopters and airplanes to provide effective and efficient maneuver and sustainment support to geographically dispersed ground forces operating in a non-contiguous environment. These aircraft play a central role since they have the ability to move troops, equipment and supplies across hundreds of kilometers or miles quickly and decisively.

#### The Joint Cargo Aircraft (JCA) Program

As previously noted, JCA is a joint acquisition program between the Army and Air Force designed to procure a commercial off-the-shelf (COTS) fleet of STOL-capable cargo airplanes to conduct intra-theater airlift. The Army will procure the JCA to support “on-demand” operations and fly TS/MC supplies and personnel to forward deployed units in remote locations. The Air Force will augment their existing fleet of intra-theater airlifters and integrate the small airlifter into its more rigid “common user” scheduling system. The Army’s JCA role in the contemporary operating environment is multifaceted. Army Aviation missions for JCA could include: air movement, aerial sustainment, and casualty/medical evacuation. These missions are aligned with the following support functions: logistical re-supply, medical evacuations, troop movement, airdrop operations, humanitarian assistance and homeland security.

The C-27J Spartan won the JCA competition in June 2007 and fielding began in September 2008 to the Army National Guard. The \$2 billion contract is for seventy eight airplanes over the course of a five year period. The contract agrees to acquire fifty four

twin-engine turboprop light cargo planes for the Army and twenty four for the Air Force (Putrich 2008). Seven planes for the Army have now been ordered, with Air Force orders expected to begin in 2010 (Putrich 2008). The contract award to L3 Communications Integrated Systems provides for the delivery of up to fourteen low rate initial production aircraft to support the operational test activities, validate the production base, and ramp-up to a full rate production. The purchase cost per unit is fixed at \$26 million dollars and the hourly operating cost is estimated to be approximately \$2500 (Initial Capabilities Document 2005, 30).

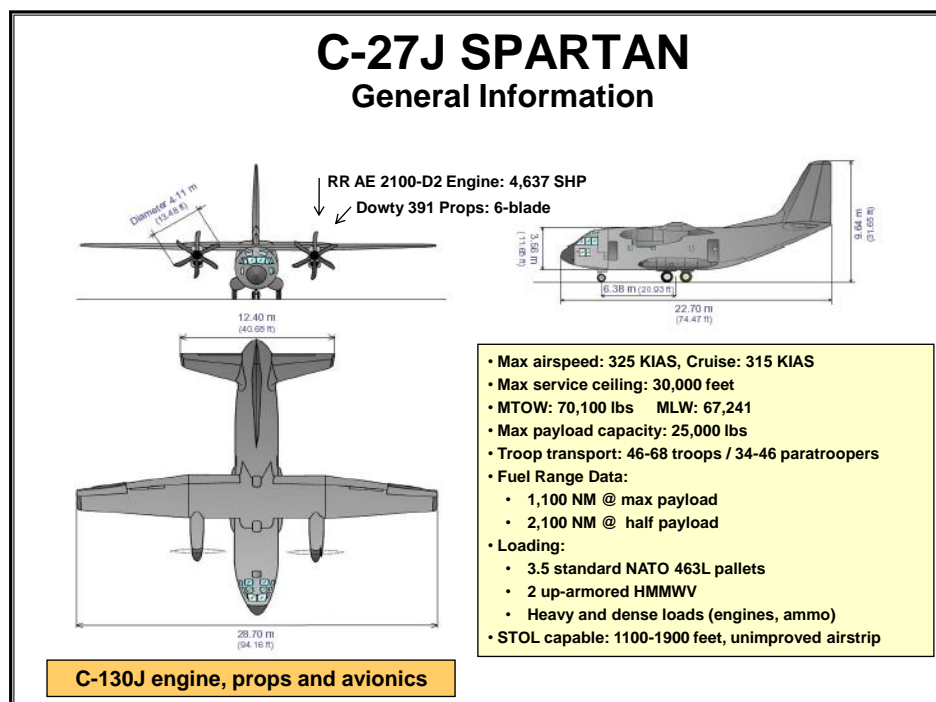


Figure 4. C-27J Overview

Source: Army Fixed-Wing Program Office, *Joint Cargo Aircraft Overview Brief* (Redstone Arsenal, AL, 2008), 16.

As shown in Figure 4, the C-27J is a very capable airlifter for its size. The Spartan has a maximum payload capacity of 25,350 pounds and can carry up to 60 troops (c-27j.com 2009). The aircraft's two gas turbine engines rated at 5,000 shaft horsepower each allow the C-27J Spartan to access a wide range of airfields, including short, unprepared airstrips in hot-and-high altitude conditions while transporting heavy loads. The aircraft has a maximum cruise airspeed of 325 knots and a range of 1,000 nautical miles when it is at the maximum payload limit of 25,000 lbs (c-27j.com 2009). At half its load capacity, the aircraft has a range of about 2,100 nautical miles (c-27j.com 2009). The C-27J is constructed with the floor strength equal to that of a C-130 Hercules, and the large cargo cabin cross-section is able to easily accommodate standard NATO 463L pallets that are commonly used by the Air Force and Army. The C-27J is capable of carrying three of these pallets, or up to two up-armored HMMWVs, as well as heavy, dense loads such as aircraft engines and ammunition (c-27j.com 2009). This will allow the aircraft to conduct trans-load operations directly with Army CH-47 Chinook helicopters or larger Air Force C-130 Hercules, C-17 Globemaster III or C-5 Galaxy aircraft. Military vehicles and equipment can be driven on and off the Spartan via a hydraulically operated rear-loading ramp. The C-27J can take-off and land at airfields less than 2,000 feet in length, meeting the Army STOL requirements as stated in the JCA program(C-27j.com 2009). The aircraft can rapidly climb and fly at a pressurized altitude of 30,000 feet, thus mitigating surface-to-air fire and missile threats. An upward-opening door is installed above the cargo ramp, which is used for air drops of pallets or container delivery system components. The air-drop speed is typically in the range 110-140 knots. For the paratroop role, the aircraft is equipped with door-jump

platforms and static lines, and can carry up to forty six fully equipped Army paratroopers (C-27j.com 2009). Airborne operation jumps can be carried out from the paratroop doors on both sides of the cargo compartment or from the cargo ramp and rear door. In the medical evacuation role, the aircraft can carry twenty four casualties on litters (stretchers) and four medical attendants. The C-27J Spartan has the similar logistical and maintenance characteristics of the Lockheed Martin C-130J Hercules medium tactical airlifter.

Combining interoperability, extended range, superior payload and STOL capability, the C-27J clearly meets Army needs as outlined in the requirements of the JCA program. By operating the C-27J, the Army and Air Force can fly into twenty nine additional airfields in Iraq and another ten airfields in Afghanistan. The C-27J is scheduled to replace all Army National Guard C-23 Sherpa cargo airplanes and portions of the C-12 Huron and C-26 Metroliner utility airplane fleets (Putrich 2008). While the C-26 and C-12 are primarily passenger carriers, the Army is transitioning to a more cargo-centric capable fixed-wing fleet designed to deliver supplies deep into the battlefield and support domestic emergencies. The C-27J will also supplement existing Army Aviation missions currently being sourced with CH-47 Chinook and UH-60 Blackhawk helicopters. Overall, the introduction of the C-27J will reduce reliance on ground convoys and the heavy workload of more expensive and maintenance intensive helicopters.

JCA is also central to the Army Aviation Modernization Program, a restructure and revitalization of aviation assets to reflect current and anticipated needs. The Army's objective for fixed-wing aircraft modernization is to reduce the fleet to five standard

platforms. To conduct fixed-wing transport of key personnel, the Army will employ short range (C-12), medium range (UC-35), and long range (C-20) utility aircraft. Providing intra-theater air movement for TS/MC troops, equipment, and supplies will be the role of C-27J. Although not a focus of this study, the final piece to the Army fixed-wing modernization will be the Aerial Common Sensor (RC-X) platform which is provide enhanced airborne reconnaissance.

### New Vision, Doctrine and the Way Ahead

In order to better understand the importance of JCA supporting the Army's intra-theater airlift mission, we must briefly review how the service is transforming. The Department of Defense consistently presents overarching direction, guidance, and vision for how the United States Armed Forces must modernize and transform to an interdependent Joint Force capable of full spectrum dominance in current documents like *The Joint Operating Environment 2008* and the *2008 Army Modernization Strategy*. These documents confirm the direction of the United States military's ongoing transformational efforts and emphasize the importance of technological and practical innovation. Evolving concepts and strategies applicable to US military operations lead to changes in organization and doctrine for the betterment of the Joint Force. A key transformation principle is that full spectrum dominance is achieved through the interdependent application of dominant maneuver, precision engagement, focused logistics and full dimensional protection. Operational concepts such as *dominant maneuver* and *focused logistics* are highly significant as they pertain to airlift and aerial delivery operations in support of ground forces arrayed across an expansive theater of operations. The need for shared, integrated and more capable airlift is all the more

apparent while the US military performs the full range of military operations with joint, inter-agency, intergovernmental and multinational partners. Subsequent service guidance for the Army published in the *Army Transformation Roadmap*, *Army Modernization Plan*, *Army Campaign Plan*, and *Army Aviation Transformation Plan* are the principle drivers that integrates the service's broad range of transformation initiatives and institutional processes to achieve the *Army Vision* as directed by the senior Army leadership.

In 2003, the United States Army implemented a fundamental shift toward a brigade-centric force. Stand-alone division and corps headquarters provide oversight for combat and support formations like the BCT, Modular Support Brigade and Functional Brigade. The Interim (Present Day to 2020) and Future Force (Beyond 2020) is structurally and operationally centered on the BCT. These brigades were formed for use as part of a mission- tailored expeditionary force package that enhance the flexibility and responsiveness of the Army (FM 3-0 2008, C-1). These expeditionary and modular forces are designed to meet the demands of a ground force conducting FSO in the contemporary operational environment (COE) from now until 2020. Figure 5 *Brigade-Sized Modular Formations* shows the various types of combat, support and functional formations within the Army. To operate beyond 2020, the Army is developing Future Combat Systems BCT (FBCT), which will be a lighter and networked force that relies on advanced technologies for greater force projection with a smaller expeditionary footprint. It is important to understand the structure of these units and the manner in which they operate in order to recognize and appreciate why Army intra-theater airlift and aerial delivery is significant.

US military units must be prepared to deploy anywhere in the world and be prepared to perform the full range of military operations including Major Combat Operations (MCO), Small Scale Contingencies (SSC), and Peacetime Military Engagements (PME). Threats range from nation state to non-nation state actors. The BCT will operate independently or as part of a larger ground force with multiple brigades and higher headquarters oversight. Divisions are the Army's primary tactical warfighting headquarters and can control up to six BCTs with a mission-tailored array of modular support and functional brigades. BCTs are designed for expeditionary deployment and can leverage advanced Command & Control (C2) systems to enable the unit to operate in large, mission-tailored areas of responsibility. Quick and efficient aerial delivery of troops, supplies and equipment to multiple and widely dispersed locations of these brigades will demand agile and precise airlift.

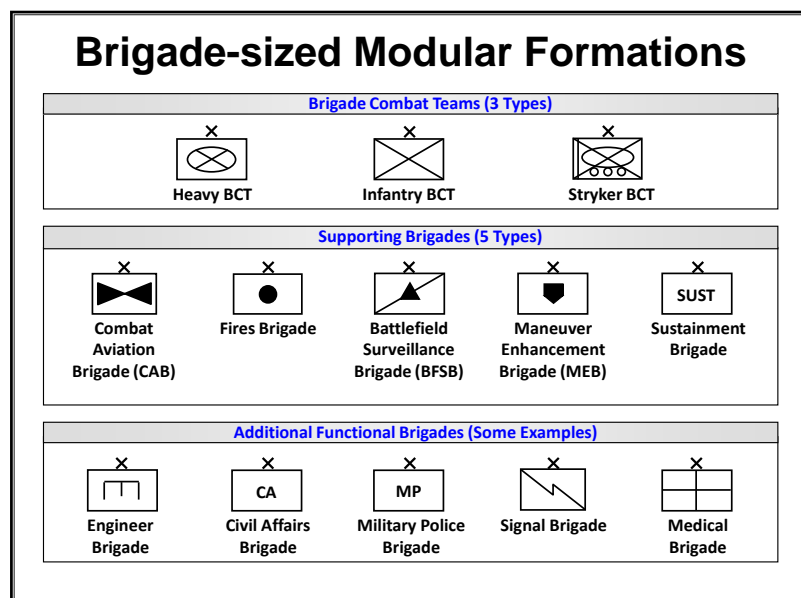


Figure 5. Brigade-Sized Modular Formations.

Source: Department of the Army, FM 3-0, *Operations* (Washington, DC: Government Printing Office, February 2008), C-6 to C-12.

Interim Force combat maneuver units like the Heavy, Stryker and Infantry BCT are the basic building block of Army tactical formations. Appendix B: *Diagrams of Heavy, Stryker and Infantry BCT formations* shows the three types of BCT formations within the Army. Heavy Brigade Combat Teams (HBCT) are combined arms brigades that employ the main battle tank, infantry fighting vehicle and self-propelled artillery within standardized combined arms maneuver battalions. The HBCT has unmatched mobility and firepower, but are many times limited by fuel consumption and maintenance readiness. The Stryker Brigade Combat Team (SBCT) is a lightly armored, motorized infantry brigade that balances combined arms capabilities with significant strategic and intra-theater mobility (FM 3-0 2008, C-7). The SBCT is designed around the Stryker eight-wheeled combat vehicle. HBCT and SBCT formations have considerable operational reach and can be heavy consumers of repair parts and large pieces of gear like replacement engines, tracks, tires and sensitive weapon system components. The Infantry Brigade Combat Team (IBCT) is a light force that utilizes the soldier as the centerpiece of its formation and is best employed in close terrain and densely populated areas while conducting an infantry mission (FM 3-0 2008, C-6). Some IBCTs have special-purpose capabilities for airborne and air assault operations. Since the IBCT has few vehicles to carry supplies and equipment, the unit is dependent on a consistent stream of sustainment support, often requiring aerial delivery of supplies by medium lift helicopters and cargo airplanes.

There are five types of Modular Support Brigades that that compliment the BCT. These brigades include: the Battlefield Surveillance Brigade, Fires Brigade, Combat or Support Aviation Brigade, Maneuver Enhancement Brigade and Sustainment Brigade.



There are also eight Functional Brigades that conduct specific functions like: Engineer, Military Police (MP), Chemical Biological Radiological Nuclear (CBRN), Air and Missile Defense, Signal, Explosive Ordnance Disposal (EOD), Medical and Intelligence. These organizations perform support functions for the three types of BCTs and are consumers of TS/MC parts and supplies for weapon systems and support equipment. Operating a larger number of C-27J airplanes to assume or supplement existing helicopter missions will greatly assist with meeting aerial delivery requirements to sustain combat maneuver, support and functional brigade operations; especially when operating across expanded areas of responsibility.

#### Army Aviation Support to Ground Forces

Army Aviation exists to support the ground fight. There are two basic kinds of aviation brigades in the Army – the Combat Aviation Brigade (CAB) and Theater Aviation Brigade (TAB) – of which there are six varying types depending on the unit mission. Aviation brigades can work directly with supported maneuver units as a brigade or by forming Aviation Task Forces (ATF) for specific missions for specific periods of time (FM 3-04.111 2007, 1-3). The six types of aviation brigades are: the Light, Medium and Heavy CAB; the Aviation Expeditionary Brigade in the Army National Guard; and the regular and composite TAB. The role of the aviation brigade is to support ground maneuver through aviation operations. The brigade can fight independently, support BCTs using pure or task-organized units, and conduct multiple independent missions requiring pure or task-organized units (FM 3-04.111 2007, 1-3). The missions of these brigades are listed in Figure 6 *Army Aviation Missions*. These roles are fully integrated with the six Joint functional areas and six Army functional areas (core missions) for the

Interim and Future Force as described in Figure 7 *Future Force Functions Concepts and Mission Linkage*.

Army Aviation Missions	
Army Warfighting Function	Aviation Brigade's Role
Movement & Maneuver	<ul style="list-style-type: none"> <li>• Support ground maneuver elements in contact through CCA.</li> <li>• Conduct air assault in support of search and attack operations.</li> <li>• Conduct movement to contact to locate and destroy enemy forces.</li> </ul>
Intelligence	<ul style="list-style-type: none"> <li>• Conduct area recon to identify adequate routes and locate bypasses.</li> <li>• Perform surveillance to confirm or deny enemy activity.</li> </ul>
Fires	<ul style="list-style-type: none"> <li>• Utilize attack recon helicopters to conduct battle damage assessment (BDA) of fires.</li> <li>• Designate for laser-guided artillery or other service munitions during joint air attack team (JAAT) operations.</li> </ul>
Sustainment	<ul style="list-style-type: none"> <li>• Perform aircraft recovery to include insertion of downed aircraft recovery teams (DARTs) and ground maintenance contact teams.</li> <li>• Support forward arming and refueling point (FARP) emplacement and resupply operations.</li> <li>• Perform casualty evacuation (CASEVAC) and aeromedical evacuation (MEDEVAC).</li> </ul>
Command & Control	<ul style="list-style-type: none"> <li>• Provide battle command on the move (BCOTM).</li> <li>• Provide retransmission capability to air and ground commander.</li> <li>• Provide air traffic services (ATS).</li> </ul>
Protection	<ul style="list-style-type: none"> <li>• Provide convoy security.</li> <li>• Conduct area security through counter mortar and rocket operations.</li> </ul>

Figure 6. Army Aviation Missions.

Source: Department of the Army, FM 3-04.111, *Aviation Brigades* (Washington, DC: Government Printing Office, 2007), 1-3.

Functional Concepts			
Joint Functional Concepts	Army Functional Concepts	Army Aviation Conceptual Operations	Army Aviation Required Capabilities
Force Application	Move	Vertical Maneuver and Air Movement	Enable Assured Mobility and Vertical Maneuver Provide Air Movement
Focused Logistics	Sustain	Aviation Sustainment	Sustain and Maintain Aviation Operations
Battlespace Awareness	See	Reconnaissance, Surveillance and Security	Ability to collect and develop actionable combat information
Force Application	Strike	Close Combat with Ground Forces (CCA), Interdiction Attack and Security	Ability to destroy and neutralize enemy targets
Net-Centric Operations Command & Control	Battle Command	Enabling Mission	Ability to manage and control airspace Execute Battle Command required capabilities for mission execution, situational awareness and fires
Protection	Protect	Enabling Mission	Ability to ensure aircraft and aircrew survivability

Figure 7. Future Force Functions Concepts and Mission Linkage.

Source: Department of the Army, *Functional Area Analysis for Army Aviation Operations Capabilities Based Assessment 2015-2024*. (Fort Rucker, AL: 29 October 2008), 12.

The CAB is organized and equipped to support Army and JIIM operations (FM 3-90-6 2006, E-2). These units are helicopter-pure brigades that conduct attack, reconnaissance, security, air assault, air movement, CASEVAC, personnel recovery and C2 missions with AH-64 Apache, OH-58D Kiowa Warrior, HH/UH-60 Blackhawk and CH-47 Chinook helicopters. Like a BCT, the CAB is a maneuver unit that is typically aligned under either a corps or division headquarters, but can operate independently. Although CABs are organized with different capabilities and subordinate units, each has a General Support Aviation Battalion (GSAB) that employs the UH-60 Blackhawk and CH-47 Chinook helicopters which is germane to this study.

Theater Aviation Brigades (TAB) conduct general support, assault and airfield operations in support of an entire theater with a blend of cargo and utility helicopters and airplanes. Unlike CABs, TABs do not contain ARBs or ATS companies. It reinforces divisional aviation brigades with assault, general support, heavy lift, MEDEVAC, or fixed-wing assets (FM 3-04.111 2007, 1-6). Another major difference is that TABs are aligned under a Theater Aviation Command (TAC) and provide support for Army or JIIM forces in the theater (FM 3-04.613 2003, 4-2). The TAB Commander organizes the brigade based on mission guidance from the TAC or the Joint Force Commander (JFC), depending upon where they are assigned (FM 3-04.118 DRAFT, 1-4). Thus, the TAC is a composite organization that plans, coordinates and executes aviation and combined operations to support theater operations (FM 3-04.118 DRAFT, 1-3). Typically, the TAC consists of two Theater Aviation Brigades (TAB) and one Theater Aviation Operations Group (TAOG). One TAB is designated as General Support (GS) and one is designated as Assault (ASLT). This study will focus on the TAB-GS because it is the

primary unit with the C-27J Spartan within its formation. There are only two TACs in the Army, and therefore there are only two TAB-GS organizations in the Army.

The TAB-GS structure includes one Headquarters & Headquarters Company (HHC), one Theater Aviation Battalion (Fixed-Wing), three General Support Aviation Battalions (GSAB) and one Aviation Support Battalion (ASB). Figure 8 *Diagram of the composite Theater Aviation Brigade (General Support)* shows the types of units within the TAB-GS and provides the number and type of aircraft assigned. The TAB-GS has a mix of over 170 aircraft to conduct air movement, aerial sustainment and medical/casualty evacuation for the theater. Within the brigade, the GSAB employs rotary-wing aircraft like the HH/UH-60 Blackhawk and CH-47 Chinook helicopter, while the Theater Aviation Battalion operates fixed-wing aircraft like the UC-35 Citation and C-23 Sherpa or C-27J Spartan. The key difference between these two battalion structures is the airframes that they operate and the intra-theater mission functions that they conduct. Appendix C: *Aircraft Specifications* provides an overview of aviation missions, performance data and lift capacity details of the C-27J Spartan, C-23 Sherpa, CH-47 Chinook and UH-60 Blackhawk.

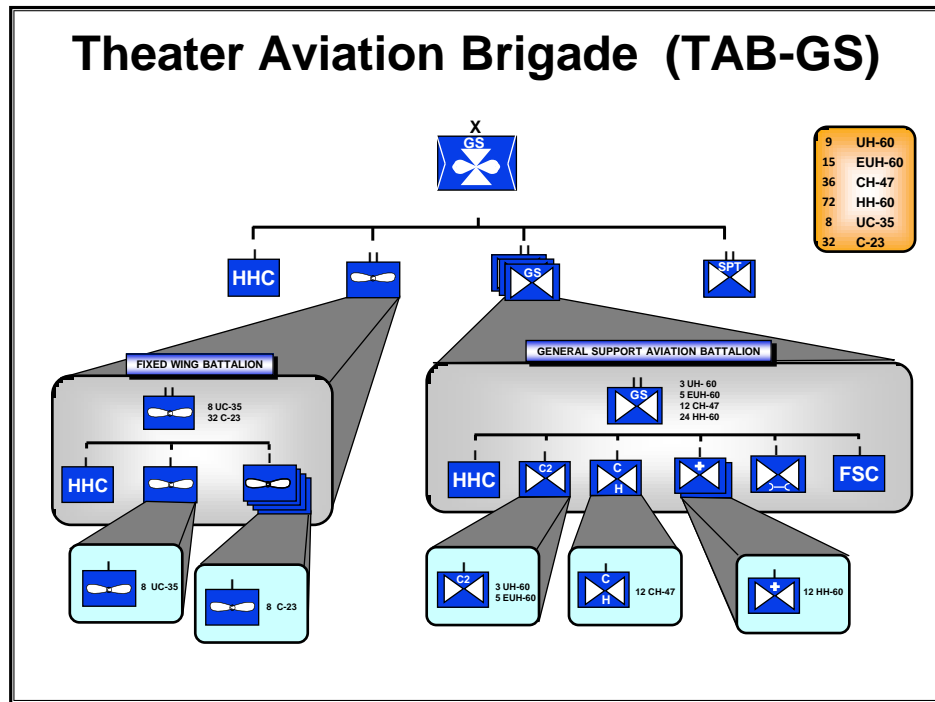


Figure 8. Diagram of the composite Theater Aviation Brigade (General Support)  
 Source: United States Army Aviation Center of Excellence, *Army Aviation Force Structure 2009 Book* (Fort Rucker, AL, 2008), 15.

The GSAB conducts key personnel transport, combat assaults, MEDEVAC, heavy and medium lift support, aircraft recovery, and the daily general support air movement needs of the supported unit. Under the Army Aviation Transformation structure, the GSAB includes: Headquarters & Headquarters Company (HHC); Alpha Company UH-60 Blackhawk Assault helicopters; Bravo Company CH-47 Heavy Lift Chinook Helicopters; Charlie Company UH-60 Blackhawk Air Ambulance helicopters; Delta Company Aviation Maintenance; Echo Company Maintenance and Forward Support; and Foxtrot Company Air Traffic Control. The technical capacities of the UH-60 Blackhawk Assault and CH-47 Heavy Lift Chinook helicopter are discussed in greater detail later in this chapter.

While the GSAB can be found in both the CAB and TAB-GS, Army fixed-wing assets conduct air movement, aerial sustainment and casualty evacuation operations for a specific theater. Under the Army Aviation Transformation structure, the Theater Aviation Battalions (Fixed-Wing) includes one Headquarters & Headquarters Company (HHC) and four fixed-wing companies. One fixed-wing company operates the UC-35 Citation or C-12 Huron for transport of key personnel, while three fixed-wing companies operate the C-23 Sherpa or C-27J Spartan for tactical transport of personnel, equipment and supplies. There are eight aircraft in each company. Just as previously mentioned about the CH-47 and UH-60, the technical capacities of the C-23 Sherpa and C-27J Spartan are discussed later in this chapter.

#### Transforming to Meet the Intra-Theater Airlift Needs of Ground Forces

Airlift operations transport and deliver forces and materiel through the air in support of strategic, operational and tactical objectives (JP 3-17 2002, IV-1). Essentially, the military services' effort to get troops, equipment, and supplies from a garrison location or point of supply is a collective process that spans strategic, operational and tactical levels. *Strategic airlift* involves moving payloads across longer distances by large fixed-wing cargo airplanes. Although sometimes augmented by commercial airlift, these strategic assets include Air Force C-5, C-17, KC-135 and KC-10 (MTCMCTEA PAM 700-2 2000, 67). Strategic airlift typically transits international and theater airspace boundaries, and is known as *inter-theater airlift*. *Tactical airlift* focuses on moving payloads over shorter distances with high precision and timing using generally smaller fixed-wing aircraft, and is also known as *intra-theater airlift*. Cargo airplanes like the C-

17, C-130, C-27J and C-23B, or helicopters like the CH-47 or UH-60 are available for these missions. Just as the name denotes, intra-theater airlift stays within the theater commander's area of responsibility. Once a payload moves from the point of origin and arrives at the Aerial Port of Disembarkation (APOD), it is organized to be moved within the theater by multiple sources of intra-theater airlift or by ground. To visualize the complete system, Figure 9 *Inter-Theater and Intra-Theater Movement* shows the Army and Air Force roles and missions from point of origin to the tactical level.

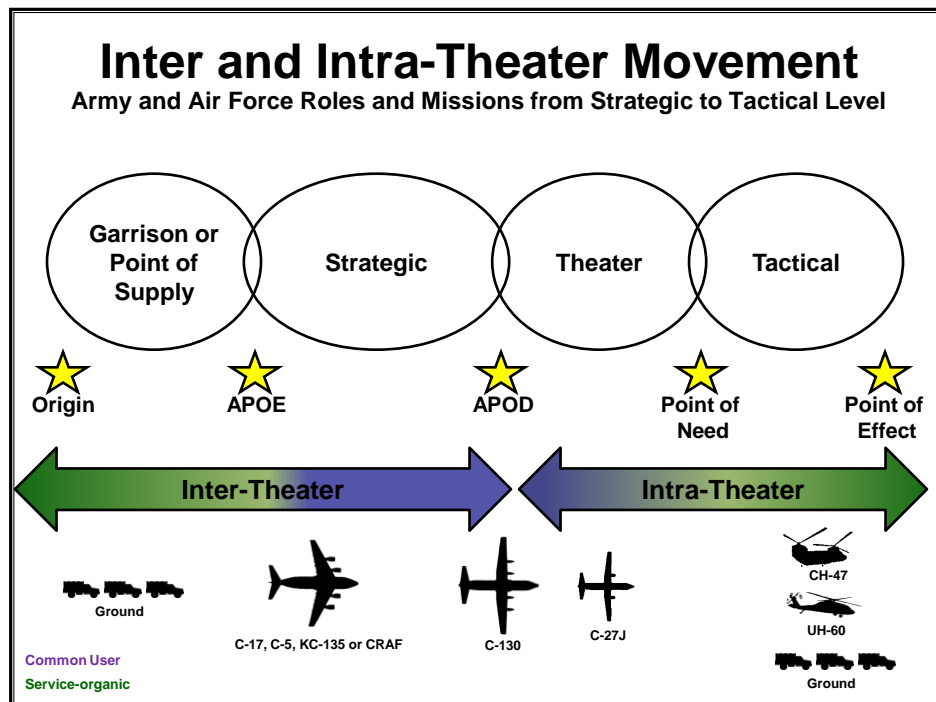


Figure 9. Inter and Intra-Theater Movement.

Source: Department of Defense, *Quadrennial Roles and Missions Review Report* (Washington, DC: Government Printing Office, 2009), 20.

The Army is traditionally a large consumer of intra-theater airlift (JP 3-17 2002, IV-7). That trend is expected to continue as the Army transforms into the brigade-centric

Interim and Future Force. Utilizing a mixed fleet of helicopters and airplanes contained in the CAB and TAB-GS, as well as the common-user airlift supplied by the Air Force, the Army conducts intra-theater airlift for rapid aerial movement, maneuver and sustainment functions in support of combined arms and JIIM operations. These aircraft provide the mobility and speed required to support the BCT, and thus must evolve, modernize and transform with these units to better support ground based maneuver units.

While conducting airlift there are three types of aerial delivery distribution methods: airland, airdrop and sling-load operations. The Army conducts all three types of these operations while sharing the intra-theater mission with the Air Force. Airland delivery is usually the most efficient delivery method for moving equipment, personnel and supplies (JP 3-17 2002, IV-9). Allowing for a great degree of payload integrity with the least risk of damaging loads, Airland delivery also maximizes the opportunity to backhaul or evacuate cargo, patients, and personnel (JP 3-17 2002, IV-10). For cargo airplanes, airland operations require airfields or airstrips that are moderately level, unobstructed and large enough for that specific aircraft to take-off and land.

During wartime, Army fixed-wing assets in the TAB are assigned to the Unified Combatant Command structure and will support the needs of the Combatant Commander (COCOM) across the range of military operations (Capabilities Development Document 2005, 2). Army fixed-wing assets in the TAB that are deployed to an AOR are placed under the command of the Joint Force Commander (JFC) and under control of the Joint Forces Land Component Commander (JFLCC) to conduct Army organic service support in a Direct Support capacity. In accordance with JP 3-17, those aircraft that are not required for Army organic service support, will be available for tasking in a General



Support capacity through the Joint or Coalition Air and Space Operations Center's (CAOC) centrally controlled common-user airlift structure managed by the Joint Forces Air Component Command (JFACC) when established.

### The Army's Intra-Theater "Airlift Gap"

The dispersed array and various locations of the BCT and supporting units cause significant logistics support challenges for aviation forces. Army helicopters are too slow and lack the range to move all required quantities of supplies efficiently and effectively for the highly mobile Interim and Future Force. However, aircraft like the CH-47 Chinook and the UH-60 Blackhawk helicopter provide the majority of air movement for TS/MC troops, equipment and supplies in current operations. The Army's only cargo airplane, the C-23 Sherpa, has significant lift capacity and performance limitations that are not conducive to transloadability and interoperability with Army or Air Force aircraft. As a result, a significant "airlift gap" based on time and distance exists. This physical gap in capability lies between where Air Force inter-theater fixed-wing airlift can deliver and where Army rotary-wing or fixed-wing aircraft could be efficiently utilized for intra-theater movement, maneuver and sustainment operations (FM 3-04.613 2003, 1-1). Due to the inability of the C-23 to cover Army intra-theater airlift mission requirements adequately, CH-47 and UH-60 helicopters are providing much more support in the theater role when they should be operating primarily in the tactical airlift role.

The projected operational environment indicates that the Army should have the capacity to fly round-trip distances in excess of 800 nautical miles without refueling and operate on short, unimproved runways. The C-27J Spartan was acquired by the Army to provide interdependent application and operations in support of *dominant maneuver* and

*focused logistics* because of the noncontiguous nature and large size of the modern day battlefield or operations area. The C-27J is the aircraft of choice to move payloads across operational and tactical distances. In support of TS/MC requirements, these aircraft will operate from Intermediate Staging Bases (ISB), theater APODs, airfields by Sea Ports of Disembarkation (SPOD) and will provide aerial delivery distribution in the theater of operations to Forward Operations Bases (FOB), where the payload will be transferred to CH-47 Chinook and the UH-60 Blackhawk helicopters for further transport to combat maneuver units staged at Combat Outposts (COP) and independent tactical locations. In some cases, the C-27J Spartan will deliver the payload directly to combat maneuver units staged at these locations. The characteristics of FSO – the dispersal of units in a noncontiguous battlespace, the high operational pace and the need for uninterrupted stream of logistics – justifies the ever-increasing demand for capabilities and services provided by Army C-27J Spartan cargo airplanes.

#### Airplane and Helicopter Comparison

Airplanes and helicopters are both important forms of military airlift, but there are significant structural and operational differences between them that effect operational capability, flexibility, cost and efficiency. Research during this study identified five specific areas of divergence between these vastly different airframe types. First, there are key differences in operational design. Airplanes are aerodynamically designed to be efficient and provide lift with wings and a tail section. In order to fly, an airplane must have an appropriate level of airspeed to push air over its wings and control surfaces which requires forward movement. Helicopters utilize a single rotor with a tail rotor for counter-torque and lateral control, or twin counter-rotating tandem rotors, to fly and

hover. Though large helicopters can lift great weight, the rotor moving parallel against the airflow in cruise flight is very inefficient. Further inefficiency is realized in the power required to operate the tail-rotor that is of little benefit with the exception of providing counter-torque and yaw-control. Helicopter flight does not require forward movement since the rotor system on the helicopter provides lift and control. In turn, these forms of vertical lift and control cause various forms of drag which in turn affect fuel efficiency and range.

Second, airplanes and helicopters are different with respect to functional and mechanical complexity. Due to the rotor system, tail rotor and power plant requirements, there are generally many more moving parts on a helicopter such as hydraulic systems, transmission gearboxes and mechanical mixing units. These systems and components are utilized for horizontal, vertical and lateral flight control, and unfortunately, are more maintenance intensive and require frequent inspections. The high-frequency vibrations caused from the rotor system effect sensitive electronic and mechanical components as well.

The third major difference between airplanes and helicopters is their ability to fly a high speeds. Depending upon the power plant system and structural limitations, airplanes are generally capable of traveling at high rates of speed. In contrast, the top speed of the helicopter is limited by the velocity of the advancing blade of the aircraft rotor system. Exceeding this velocity causes a phenomenon known as “retreating blade stall” and causes an imbalance of lift and aircraft instability.

A fourth important difference is how airplanes and helicopters take-off and land. Airplanes must take off horizontally and can move in a forward direction to generate

airflow over the wing and control surfaces to create lift and maintain aircraft control. Consequently, airplanes need takeoff and landing space. Helicopters, on the other hand, can take off and land vertically and have the ability to hover in one location at varying altitudes which require higher consumption of fuel.

The fifth and final major difference is that all Army cargo and utility helicopters have the capacity to carry loads both internally and externally with a sling-load system, and airplanes do not. Cargo airplanes must carry their payloads internally in an allowable cabin load (ACL) area because the aircraft cannot be configured with a sling-load system. Due to great differences between airplanes and helicopters, each is used for a specific purpose. This general understanding shows that airplanes are less expensive to operate and can transport more passengers and heavier payloads over longer distances in less time than helicopters, while helicopters are more maneuverable and have no airstrip requirements to take off and land.

#### Airlift Requirements of the BCT

The BCT has the ability to deploy within five days of notification as an independent unit or as a mission-tailored force package. After being inserted into a Joint Operations Area (JOA), the BCT must be able to conduct an operational move by ground up to 400 kilometers to immediately begin FSO (Initial Capabilities Document 2005, 11). The BCT deploys with a combat load that allows it to operate up to three days without resupply, and will operate in a non-linear area of influence within a 75 kilometer radius inside a 500 kilometer wide by 500 kilometer deep JOA (Initial Capabilities Document 2005, 11). The size of the area of influence and JOA is situational and mission dependant, often limited by the mobility capacity of the BCT. To maintain FSO

capability in a wartime environment, these brigades must be resupplied every three to seven days by air or ground. While it is conceivable that logistical resupply will be conducted by distances exceeding 400 kilometers, ground lines of communication (LOC) may not be secure and the BCT will require aerial sustainment. To meet these needs, Army cargo aircraft must be able to carry 18,000 lbs of cargo for a range of 1,200 NM or a mission radius of 600 NM (Initial Capabilities Document 2005, 11). This allows the aircraft to transport and off-load the cargo 600 NM, and then return to base without refueling. Due to the remote locations of some combat units, Army cargo aircraft must be STOL-capable and be able to operate at airfields with conventional airports or unimproved airstrips.

Resupplying BCTs are especially challenging as they require a significant amount of logistical support during independent operations. For example, an IBCT that is manned with 3,527 soldiers requires 107,900 lbs of dry cargo, 20,700 gallons of fuel and 15,500 gallons of water per day while using average consumption rates in a dry/arid environment. An SBCT manned with 3,982 soldiers, requires 143,700 lbs of dry cargo, 26,100 gallons of fuel and 17,300 gallons of water per day while using similar consumption rates. Perhaps the greatest challenge is the 3,851 soldiers of an HBCT which requires 147,700 lbs of dry cargo, 55,900 gallons of fuel and 16,700 gallons of water per day under the same conditions. Utility and cargo aircraft move forces and materiel quickly throughout the battlespace. If aerial delivery is the desired or sole means of supporting these units, the airlift requirement could require up to 220 pallets per day to sustain their formations under these environmental conditions. Appendix D details the

Consumption Rates and Resupply Requirements for an IBCT, SBCT and HBCT by class of supply for this example.

As the largest consumer of airlift, the Army will continue to leverage the capacity of Joint military airlift for passenger and cargo movement, combat employment and sustainment, aeromedical evacuation, special operations support and operational support airlift (JP 3-17 2006, IV-3). But the Army will also continue to utilize other means of resupply such as military ground convoys and commercial line-haul that offer the most efficient means of to support the entire force. The C-27J is not intended to be a sole-provider for intra-theater airlift support to the BCT. On-call airlift (Direct Support) flown by the C-27J Spartan is simply a viable and valuable method of conducting MC/TS aerial distribution and resupply for Army forces.

#### Comparing Capability, Flexibility and Efficiency

The C-27J Spartan is the best platform to transport TS/MC troops, supplies and equipment to forward locations due to its increased payload capacity, performance and fuel range. See Figure 10 *Army Aircraft Comparison Chart* for comparison of Army rotary-wing and fixed-wing cargo and utility airframes. Appendix C: *Aircraft Specifications* provides more performance data and lift capacity details of these aircraft. The Spartan is capable of carrying a 25,350 lb maximum payload to a range of 1,000 nautical miles, or a 12,675 lb half payload to a range of 2,100 nautical miles at 315 knots cruise airspeed without refueling. The cargo hold area size of the C-27J is 2,000 cubic feet, large enough to meet the vast majority of Army TS/MC needs. The C-27J can fly at a max service ceiling of 30,000 feet above mean sea level (MSL).

In contrast, the Army's C-23 Sherpa is the far less capable aircraft that the C-27J is replacing. The twin-engine Sherpa currently conducts fixed-wing intra-theater airlift, airdrop and aeromedical evacuation functions for the Army and the 43-aircraft fleet is scheduled to be retired by 2013. The C-23 is capable of carrying a 7,280 lb maximum payload to a range of approximately 446 nautical miles, or a 3,640 lb half payload over 1,150 nautical miles while flying 180 knots. The cargo hold area size of the C-23 is much smaller as well at only 1,230 cubic feet. Perhaps the greatest weakness of the C-23 is the max service ceiling of 13,950 feet MSL which requires the crew to utilize supplemental oxygen. This altitude alone ensures the Sherpa remains within the engagement zone of most surface-to-air missile systems and limits its use in areas of mountainous terrain, as seen in Afghanistan.

Aircraft Overview & Comparison				
	C-27J Spartan	C-23B+ Sherpa	CH-47F Chinook	UH-60M Blackhawk
Max Airspeed	325 knots	190 knots	170 knots	193 knots
Cruise Airspeed	315 knots	180 knots	130 knots	150 knots
Max Payload	25,350 lbs	7,280 lbs	26,000 lbs (external)	9,000 lbs (external)
Half-Payload	12,675 lbs	3,640 lbs	13,000 lbs (internal)	4,500 lbs (external)
Range @ Max Payload	1,000 NM	446 NM	50 NM	50 NM
Range @ Half-Payload	2,100 NM	850 NM	325 NM	225 NM
Max Service Ceiling	30,000 ft	13,950 ft	18,500 ft	19,000 ft
Tactical Takeoff Distance	1,903 ft	1,850 ft	VTOL	VTOL
Cubic Feet of Cargo Space	2,000 cu ft	1,230 cu ft	1,474 cu ft	410 cu ft
Carry 463L Pallets (internal)	3	0	3	0
Max Passengers	68	30	55	11
Max Paratroopers	46	27	33	8

Figure 10. Army Aircraft Comparison Chart

Sources: Paul Jackson, *Jane's All the World's Aircraft*. (Alexandria, VA: Jane's Information Group, Sentinel House, 1992-93), 312-313; Paul Jackson, *Jane's All the World's Aircraft* (Alexandria, VA: Jane's Information Group, Sentinel House, 2006-07), 353-355, 675, 881.

The Army's CH-47 Chinook is one of the most capable medium-lift cargo helicopters in the Department of Defense inventory. The CH-47 can carry internal or external payloads and is primarily used for the tactical transport ground forces, supplies, ammunition and other battle-critical cargo. The twin-engine helicopter has a tandem rotor system and features a large rear loading ramp for ease of cargo handling. The tandem-rotor design and three external cargo hooks offer significant center-of-gravity advantages during sling-load operations. While there are 425 Chinooks in the Army inventory, approximately 340 Chinooks are assigned to conduct tactical medium-lift in



support of general-purpose forces. This figure does not include flight training or special operations configured aircraft.

The CH-47 is capable of carrying a 26,000 lb maximum payload externally to a range of 50 nautical miles at 130 knots airspeed, or a 16,000 lb external or internal payload to a range of approximately 100 nautical miles at 170 knots. The cargo hold area size of the CH-47 is 1,474 cubic feet and can accommodate up to three standard 463L pallets or 55 passengers. The CH-47 can fly at a max service ceiling of 18,500 feet MSL if the crew and passengers utilize supplemental oxygen. The maximum payload weight capacity of the C-27J is relatively comparable to the CH-47 Chinook for short distances up to 50 miles (25,350 versus 26,000 lbs respectively). But that is overshadowed by the fact that the C-27J can carry 25,350 lbs to a range of 1,000 nautical miles or 13,200 lbs to a range of 2,100 miles. The C-27J exceeds the CH-47 max payload range by approximately 950 nautical miles and the practical payload range by 2,000 nautical miles. For internally carried cargo, the C-27J cargo hold area is 526 cubic feet larger than the CH-47. The C-27J flies a cruise airspeed of 315 knots, which outpaces the CH-47 cruise airspeed of 130 knots by 185 knots.

The UH-60 Blackhawk is the Army's medium-lift utility helicopter used for air assault, general support, command & control, aeromedical evacuation and special operations. The aircraft has a single-head rotor system with four blades and two gas-turbine engines. There are over 1,400 Blackhawks in the Army inventory in many variants and configurations, of which there are approximately 992 available for supporting tactical mission support of general-purpose forces. This figure does not include flight training, aeromedical evacuation or special operations aircraft.

The Blackhawk is capable of carrying a 9,000 lb maximum payload externally to a range of 50 nautical miles at 150 knots airspeed, or a 2,500 lb internal payload to a range of approximately 315 nautical miles at 193 knots. The cargo hold area size of the UH-60 is 410 cubic feet and accommodates up to 11 passengers and floor loaded cargo only. In other words, no 463L pallets can be carried aboard the Blackhawk. The UH-60 can fly at a max service ceiling of 19,000 feet MSL if the crew and passengers utilize supplemental oxygen. The C-27J can carry 16,350 lbs more max payload than the UH-60L/M and 10,700 lbs more max payload than the UH-60A. The C-27J Spartan exceeds the UH-60 max payload range by approximately 950 nautical miles and the half payload range by 1,785 nautical miles. The C-27J cargo hold area is 1,590 cubic feet larger than the UH-60 if internal cargo is to be carried. The cruise airspeed of the UH-60 is 150 knots and is outpaced by the C-27J by some 165 knots, which is over twice as fast.

The propulsion and more aerodynamic lift of the C-27J provides a significant increase in aircraft range by 950 nautical miles or better in comparison to the CH-47 and UH-60 helicopter transports in tactical or max load configurations. The cargo hold area is five times larger than the UH-60 and twenty seven percent larger than the CH-47. The C-27J exceeds all max service ceiling requirements of the other compared aircraft by 12,500 feet MSL or better. The Spartan offers another significant benefit over utility and cargo helicopters; it can fly above 10,000 feet MSL without the crew or passengers having to utilize supplemental oxygen which facilitates medical or casualty evacuation. Operating at higher altitudes also allows the C-27J to fly over higher terrain and better mitigate surface to air missile (SAM) and surface to air fire (SAFIRE) threats. During longer flight legs, the C-27J can also make use of the earth's jet-streams by achieving

greater altitude, which equates faster airspeeds and better fuel efficiency. Refer to Figures 11 and 12 for Payload Weight & Range and Airspeed Comparisons.

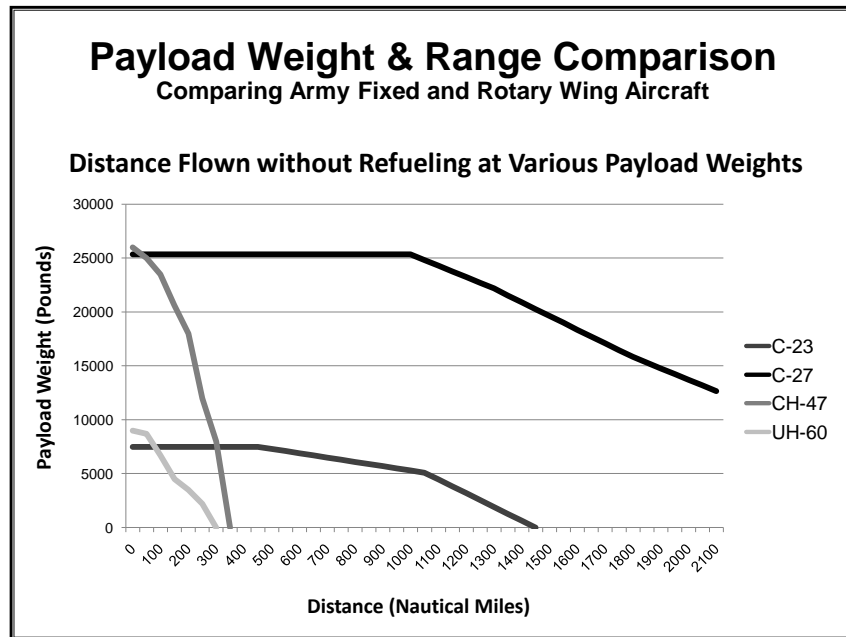


Figure 11. Payload Weight & Range Comparison  
*Source:* Created by author.

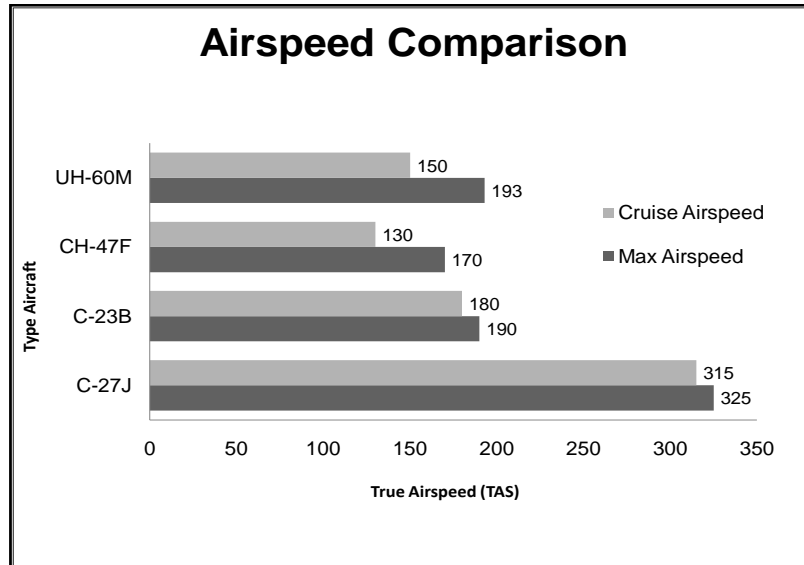


Figure 12. Airspeed Comparison.

Source: Paul Jackson, *Jane's All the World's Aircraft* (Alexandria, VA: Jane's Information Group, Sentinel House, 1992-93), 312-313; Paul Jackson, *Jane's All the World's Aircraft*. Alexandria, VA: Jane's Information Group, Sentinel House, 2006-07, 353-355, 675, 881.

Short Takeoff and Landing (STOL) aircraft have the ability to clear a 50-foot obstacle within 1,500 feet of commencing takeoff or to stop within 1,500 feet during landing after passing over a 50-foot obstacle (JP 1-02 2008, 498). Vertical Takeoff and Landing (VTOL) aircraft have the capability to taking off or land vertically (JP 1-02 2008, 585). The C-27J Spartan is a STOL aircraft and the CH-47 Chinook and UH-60 helicopter are VTOL aircraft. STOL aircraft like the C-27J are designed to take-off and land on short runways or unimproved airstrips due to the lift capacity provided by two Rolls-Royce E2100D2 engines rated at 4,637 SHP each and large wing surfaces. With a max takeoff weight or maximum landing weight of 67,241 lbs, the C-27J can takeoff from an airstrip as short as 1,903 feet or can land at an airstrip as short as 1,115 feet (c-27j.com 2009). To land or take-off with an airplane, these large areas must be obstacle-

free and relatively flat, whereas VTOL aircraft like the CH-47 and UH-60 are much more flexible and can take-off and land in more confined areas.

### Assessing Airlift Capability

The C-27J will bring a tremendous airlift capability to the United States Army and will effectively assume or supplement existing utility and cargo helicopter missions. Under the initial purchase of fifty four aircraft for the Army from FY 2008 to 2013, the service will operationally employ forty eight aircraft and utilize the remaining six aircraft for training. Currently there are two Theater Aviation Battalions in the Army, each regionally aligned under a TAB-GS. Under current plans, the service will source six C-27J fixed-wing companies with eight aircraft a piece within the two Theater Aviation Battalions. In other words, each Theater Aviation Battalion will employ twenty four C-27J aircraft with three line companies. Though each Theater Aviation Battalion can deploy as a battalion-sized element, mission tailored company-level force packages are the norm for an operational deployment (FM 3-04.613 2003, 4-3).

As previously discussed, to support the various types of BCTs in the Army, there must be transport capacity to move 53.9 to 73.8 short tons of cargo daily for each BCT deployed. Those figures equate to 172 to 220 pallets per day for aerial delivery. Internal payloads on an aircraft are normally palletized on standard 463L pallets. If cargo is rolling stock or has an individual container that can be safely secured to the interior of the aircraft, then it does not have to be palletized. Individually, the C-27J can carry a maximum payload of 25,350 lbs or 12.6 short tons of unpalletized cargo or the same amount of payload weight on three pallets.

Common airmobility formulas illustrated in Chapter 3 are utilized to determine and evaluate cargo sorties required per day and lift capability/capacity. To determine the number of cargo sorties required per day (CSR/D), one must divide the airlift requirement by the average payload or pallet capacity of a given airframe. For example, assuming maximum payload capacity is not exceeded, it would take sixty total sorties for a C-27J company to move 180 pallets. If six C-27J aircraft are available in an eight-ship company, then each aircraft and crew will fly ten sorties per day. Determining CSR/D provides an estimate of how many sorties will be required, but does not take functional planning factors into account. Objective airlift capability of an airlift asset is relatively predictable for a 24 hour period by applying estimated aircraft block speeds, average payloads, aircraft use rates, productivity factors, and operational readiness rates to air mobility planning formulas. To better understand the level of functional capability, common air mobility planning factors like Fleet Capability and Fleet Capacity can be useful.

*Fleet Capability* measures and estimates the number of pounds, short tons or pallets delivered within the theater per day by an aircraft (AFPAM 10-1403 2003, 4). To determine this, one must multiply the average payload by the number of available aircraft by the utilization rate and divide that figure by the number of round trip flight hours required for the mission. Figure 13 shows the singular transport capability for the C-27J using the same formula with various supply line distances. The formula can also effectively assess transport capability for various unit level operations. For example, to support a 400 nautical mile supply line the theater Fleet Capability of a C-27J company is 152 short tons for non-palletized cargo. Those figures assume there are six aircraft

available flying 270 knot block speeds with an average payload of 19,000 lbs at an eight hour use rate if the cargo does not have to be palletized. If all cargo is palletized aerial delivery, this that company under the same conditions can haul forty eight pallets per day up to the same weight. To support a 325 nautical mile supply line under the same conditions, a C-27J company can transport 190 short tons unpalletized or up to the same weight on sixty pallets. To support a 200 nautical mile supply line under the same conditions, a C-27J company can transport 304 short tons unpalletized or the same weight on 96 pallets. Determining Fleet Capability for a theater is a highly useful tool for understanding the number of pounds or short tons that can be delivered by an aircraft, and is a preferred formula by military planners for deliberate forecasting because it accurately relates variables affecting airlift.

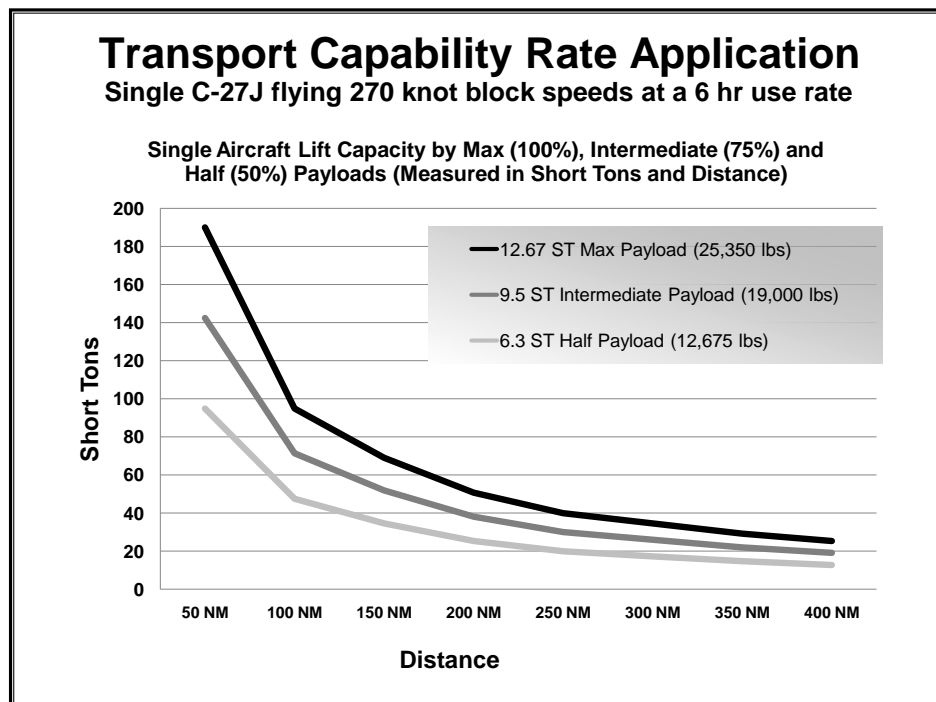


Figure 13. Transport Capability Rates

Source: Created by the author.

*Fleet Capacity* measures and estimates airlift capacity of a particular aircraft in million ton miles per day (MTM/D). To determine Fleet Capacity, one must multiply the number of available aircraft by block speed by average payload by utilization rate by productivity factor and divide that figure by one million. Civilian agencies are accustomed to utilizing Fleet Capability in terms of MTM/D, so military planners often use this formula when comparing civil and military aircraft (AFPAM 10-1403 2003, 4). The Fleet Capacity of a C-27J company is 156 MTM/D if there are six aircraft available flying 260 knot block speeds with an average payload of 25,000 lbs at an eight hour use rate and a fifty percent cargo transport productivity factor.

Army CH-47 and UH-60 helicopters provide much more support in the intra-theater role when they should be operating primarily in the tactical airlift role. As previously discussed, helicopters are very effective at carrying heavy sling-loads that are comparable to their respective max payload up to 50 nautical miles but are limited by slower airspeeds and fuel range. Clearly, an endless number of scenarios with varying results can be derived from examining different airframes when using the Fleet Capability or Fleet Capacity formulas. But the bottom line is, if comparing functional airlift capability with similar numbers of aircraft and equivalent payloads, the helicopter will always be grossly outpaced due to slower airspeeds and fuel range limitations. The challenges associated with carrying more payloads and pallets over extended distances alone calls for a better balance between fixed-wing and rotary-wing airlifters.

The Fleet Capability and Fleet Capacity formulas are useful for determining capability to support airlift requirements. The Fleet Capability for all fifty four C-27J Spartans supporting a 400 nautical mile radius of coverage at max payload and eight hour



use rates is 1,825 short tons. For aerial delivery, this would require 432 pallets. In terms of Fleet Capacity in ton miles, fifty four C-27J aircraft provide for 1,423 MTM/D. In the contemporary operating environment, it is realistic for a light infantry division employing four IBCTs to have a requirement for 216 short tons of supplies. Daily sustainment of these units is a challenge; especially if operating in an expanded non-contiguous battlespace like Afghanistan or Iraq. These supplies will be transported via various methods, but if there was a combat operation that required aerial delivery, the supplies would need to be carried on 688 pallets on both helicopters and airplanes depending upon the supply line distance. An armored division employing four HBCTs could have a requirement for 296 short tons carried on 880 pallets. Incidentally, these figures do not include the Support Brigade or Functional Brigade requirements and are intended to reflect the daily supply rates for combat maneuver formations that may require TS/MC supplies.

The Army needs to have the capacity to deploy a greater number of C-27J Spartans working in concert with CH-47 and UH-60 helicopters. The evidence shows that the initial purchase of fifty four aircraft is good, but seventy two would be significantly better. Sourcing at least seventy two aircraft would allow sixty four aircraft to be assigned to two Theater Aviation Battalions and eight aircraft at the JCA Training Center. The collective operational Fleet Capability for the fixed-wing Theater Aviation Battalions employing 64 aircraft across a 400 nautical mile supply line would be 2,163 short tons or 512 pallets per day. In terms of Fleet Capacity in ton miles, sixty four aircraft provide for 1,687 MTM/D. Those figures are naturally influenced by average payload weights and operational readiness rates. Furthermore, by drawing from a pool of

sixty four aircraft within eight companies, the Army would have the ability to maintain twenty five percent of the fleet deployed via two C-27J companies to a single site or multiple locations. Having two companies deployed supports a 1:4 deployment-to-dwell time ratio which is more desirable and sustainable with respect to the Army Force Generation (ARFORGEN) model. Two C-27J companies comprised of sixteen aircraft, with an aerial delivery mission radius of 400 nautical miles, can deliver 540 short tons or 128 pallets of cargo daily. As supply line distances decrease, airlift capability increases due to shorter mission cycle times. This increase in capability better balances the cargo tonnage movement capability for Army Aviation assets, and enables more CH-47 and UH-60 helicopters to conduct tactical missions.

Acknowledging the design role of the C-27J, the aircraft is an ideal supplement to Army CH-47 Chinook and UH-60 Blackhawk helicopters and Air Force C-130 cargo aircraft. By comparison, the UH-60 and CH-47 helicopter are designed for medium and heavy lift purposes and carry similar or smaller loads at less than half the speed and for considerable shorter ranges. The C-27J will bring a tremendous airlift capability to the Army and will effectively assume or supplement existing utility and cargo helicopter missions. Common airmobility formulas are practical while managing airlift requirements versus capability or capacity. These formulas can be useful in portraying the functional airlift capacity of the C-27J while examining the potential aerial delivery requirements for modular and expeditionary combat brigades. Evaluating functional airlift capability with similar numbers of aircraft and comparable payloads, the helicopter will always be grossly outpaced due to slower airspeeds and fuel range limitations. While aircraft like the CH-47 and UH-60 generally increase the intra-theater airlift

capability of the Army, the C-27J is the ideal platform to transport supply items and personnel to forward locations due to its increased payload capacity, performance and fuel range. The Army must leverage the airlift capacity of the C-27J in order to operate in an expanded non-contiguous battlespace and provide sufficient intra-theater support.

### Efficient Transloadability and Interoperability

The C-27J will augment the inter-theater airlift efforts Army helicopters and Air Force cargo airplanes, and therefore must have characteristics that are consistent with transloadability and interoperability. *Transloading* actions occur when an aircraft payload must be transferred from one mode of air transport to another. In the military, it is normally accomplished when larger strategic lift aircraft cannot be used for the entire trip because the aircraft is too large to operate or is incompatible with the destination airfield or airstrip. Sometimes, bulk cargo arrives at one destination and must be broken down and distributed to multiple locations at various distances. Each time an aircraft must be downloaded or uploaded it takes time. Sometimes there is greater expense associated with delaying cargo, or even risk associated with moving cargo from one aircraft to another. Consequently, transload services on military airbases have specialized material handling equipment (MHE) for standardized pallets and containers to load and unload aircraft quickly and efficiently.

Due to the compatible dimensions of the cargo compartment (depth and cross section) and roll-on/roll-off capability, the C-27J is interoperable with the CH-47 Chinook heavy-lift helicopter and intra-theater airlifters like the C-5, C-17 and C-130. The dimensions of the cargo compartment of the C-27J are designed to accommodate equipment commensurate with medium lift. For example as shown in Figure 5-14 *C-27J*

*Transport Capabilities*, the aircraft can carry tactical vehicles, small helicopters or weapon systems in the rear of the aircraft such as two up-armored High Mobility Multipurpose Wheeled Vehicles (HMMWV), one light helicopter, or one M119A1 105 mm Towed Howitzer (c-27.com 2009). The cargo hold is ideal to carry helicopter rotor blades and tank or vehicle engines. All vehicles can be driven or winched on and off the aircraft via a hydraulically operated rear-loading ramp.

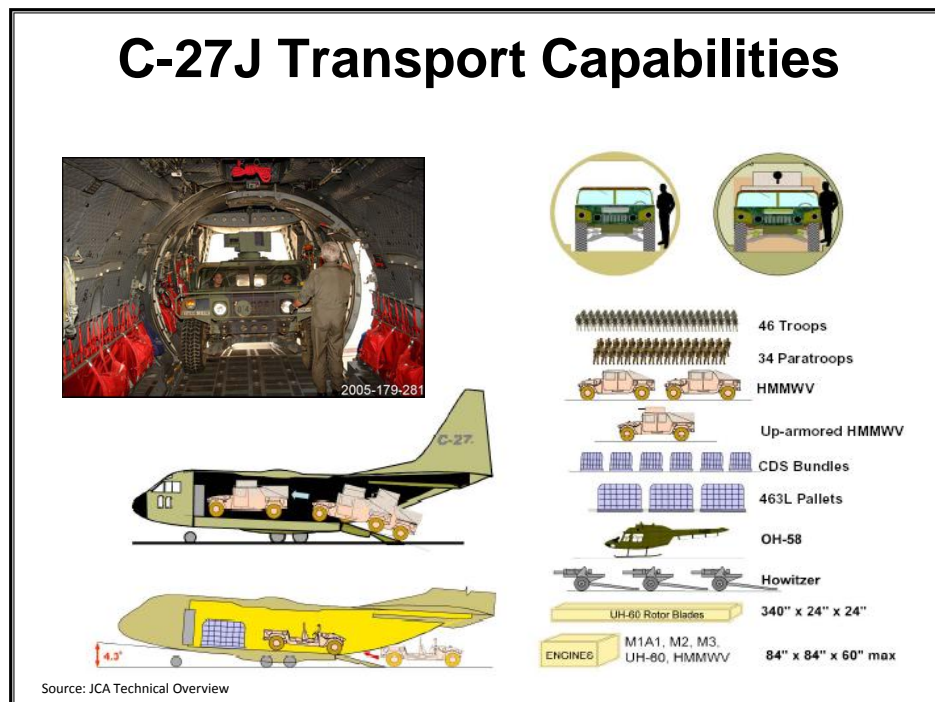


Figure 14. C-27J Transport Capabilities.

Source: Army Fixed-Wing Program Office, *Joint Cargo Aircraft Overview Brief* (Redstone Arsenal, AL, 2008), 17.

The C-27J has the same loading system as the C-130 and can carry three NATO standard 463L pallets. The loading system of the C-27J consists of rollers mounted in the floor of the cargo compartment for handling 463L pallets and specialized cargo. The

rollers can be adjusted to leave a solid flat surface if required. 463L pallets and cargo is loaded onto the C-27J through the hydraulically-operated main loading ramp and door assembly located in the rear of the aircraft. The ramp can also be lowered to the ground for loading and unloading of wheeled vehicles. Tie-down fittings for securing cargo are located throughout the compartment. The 463L pallet is aluminum surfaced, balsa wood-core pallet designed for roller type handling in and around cargo aircraft (MTCMCTEA PAM 700-2 2000, 65). The pallet secures cargo by restraining nets and straps, and can carry up to 10,000 pounds of cargo. The usable space on a pallet is 104 inches wide by 84 inches long. Pallets can be configured into a daisy-chained (linked) to carry items that exceed the length limit of a single pallet (MTCMCTEA PAM 700-2 2000, 66). Standardized pallets and loading systems allow cargo to be transloaded directly from another cargo aircraft without delay. Figure 15 shows how the C-27J will conduct focused logistics support on a typical airlift mission.

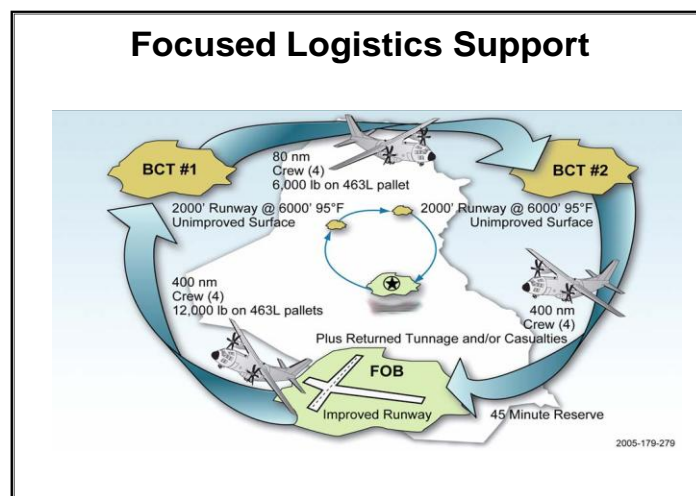


Figure 15. C-27J Focused Logistics Support Concept  
Source: Army Fixed-Wing Program Office, *Joint Cargo Aircraft Overview Brief* (Redstone Arsenal, AL, 2008), 15.

Conducting FSO requires increased compatibility between the military services, and therefore equipment must be interoperable. *Interoperability* is the ability of a system to work with another system without special effort. The Department of Defense makes an effort to set standards so that various tactical equipment and aircraft are interoperable for cost and operating efficiency purposes. This is a significant effort, considering the military regularly upgrades and modernizes equipment. The C-27J is designed to be interoperable with the existing fleet of C-130s in a deliberate effort to have operational commonality and reduce operating and maintenance costs. For example, approximately 30% of avionics components and propulsion system, sixty percent of the Flight Mission Computer and Flight Management software and the entire avionics system architecture design are common between the C- 27J and C-130J (c-27j.com 2009). The cockpit design allows for the use of night-vision equipment utilized by Army helicopter crews while operating in a tactical environment at night. The transloadability and interoperability of the C-27J facilitates timely, efficient and effective airlift support to the warfighter while integrating with the efforts Army helicopters and Air Force cargo airplanes.

#### Aircraft Costs

The C-27J Spartan is a commercial-off-the-shelf (COTS) procurement. No research and development efforts are planned by the Department of Defense on the C-27J because the technology and design are mature. Production maturity is high since the aircraft is in use by other countries as an airlifter, and in use commercially by various companies in private industry. Production lines are already established which is advantageous to procurement costs. The Army awarded a \$2.04 billion contract in June

2007 with L3 Communications for an initial quantity of seventy eight aircraft to be delivered to the Army and Air Force from FY 2008 to 2013 (GAO-08-467SP 2008, 99).

The fixed purchase cost of the aircraft is approximately \$26 million each. The Army is buying new CH-47F helicopters at about \$32 million each, about \$6 million per unit more than the cost of the C-27J. The new UH-60M Blackhawk costs approximately \$16.2 million each, approximately \$9.8 million less than the C-27J. The initial purchase of seventy eight aircraft is a sound purchase decision, especially if the JCA program stays on time and on budget. Figure 16 shows the purchase costs of various Army aircraft.

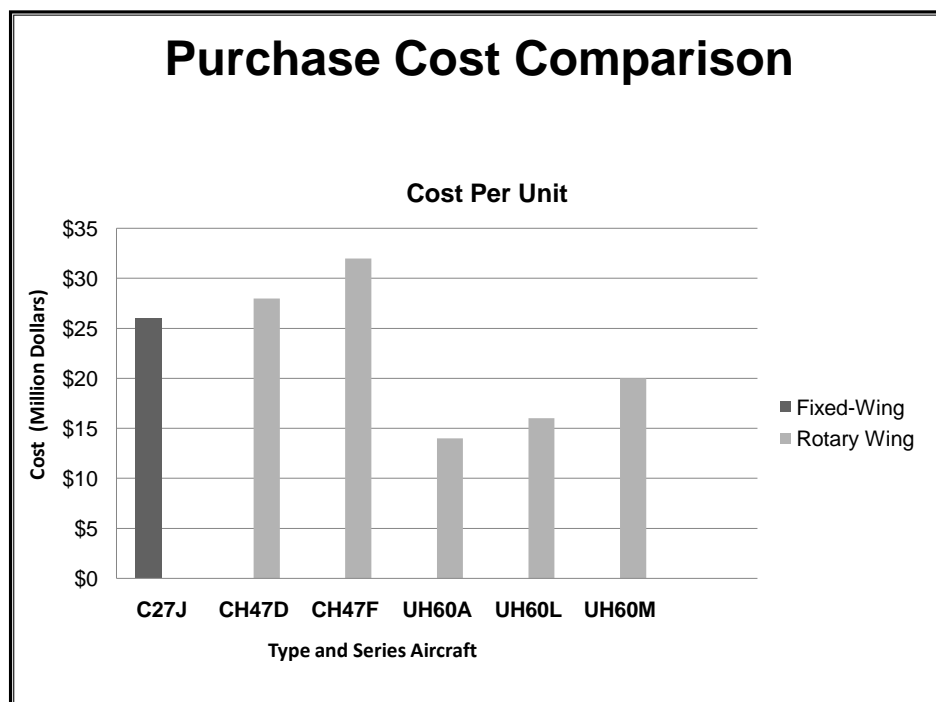


Figure 16. Purchase Cost Comparison  
*Source:* TRADOC System Manager-Lift, Fort Rucker, AL, 2009.

The C-27J is relatively inexpensive to operate. The operating cost (or cost per flight hour) of the C-27J is approximately \$2,500 per hour. By reviewing Operating and Support Management Information System (OSMIS) costs associated with the various series of UH-60 and CH-47 helicopters, operating costs can be compared with the C-27J. The UH-60L cost per flight hour is \$2,291 and includes only consumable and repairable parts with POL and is based on the average of a significant amount of flight hours. The UH-60A cost per flight hour is \$2,958 and the UH-60M based on limited flight hour information is \$2,471. The Army CH-47D cost per flight hour is \$10,442 and the new CH-47F is \$10,437. Figure 17 shows the operating costs of various Army aircraft.

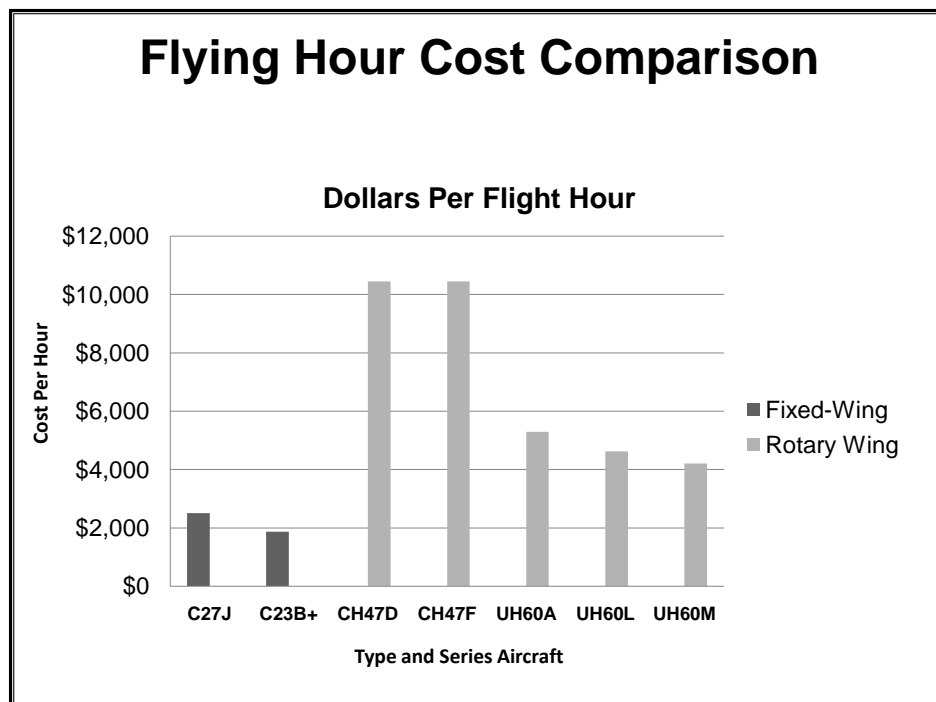


Figure 17. Operating Cost Comparison

Sources: Department of the Army, *Initial Capabilities Document for Aerial Sustainment Capability* (Fort Rucker, AL, 2005), 31; Department of Defense, *FY 2009 Reimbursable Rates - Fixed Wing* (Washington, DC, 2008), 1; Department of Defense, *FY 2009 Reimbursable Rates - Rotary Wing* (Washington, DC, 2008), 1.



As depicted in Figure 18, if there was a requirement to conduct an air movement mission with an airland or airdrop delivery to move a TS/MC payload that weighed 12,000 lbs across a 400 nautical mile supply line, the C-27J would be the most capable, efficient, flexible, and economically resourceful option in the Army inventory. To support a 400 nautical mile supply line, an aircraft must fly to the destination and back which equates to 800 nautical miles. To fly 800 nautical miles with a 12,000 lbs internal payload to the mission destination and return empty, the CH-47 would take approximately 6.6 flight hours and require two fuel stops to complete the mission. There would be a requirement for no less than two Forward Arming and Refuel Points (FARP) for this mission in order to service the CH-47. The C-27J could complete the flight in total without refueling with a total flight time of 2.5 hours. If the CH-47F costs \$10,437 per hour to operate, the mission would cost \$68,884. The same mission flown by the Spartan would cost \$6250, which is less than ten percent of the operating cost of the Chinook. Even more cost savings are realized by flying greater tonnage over longer distances.

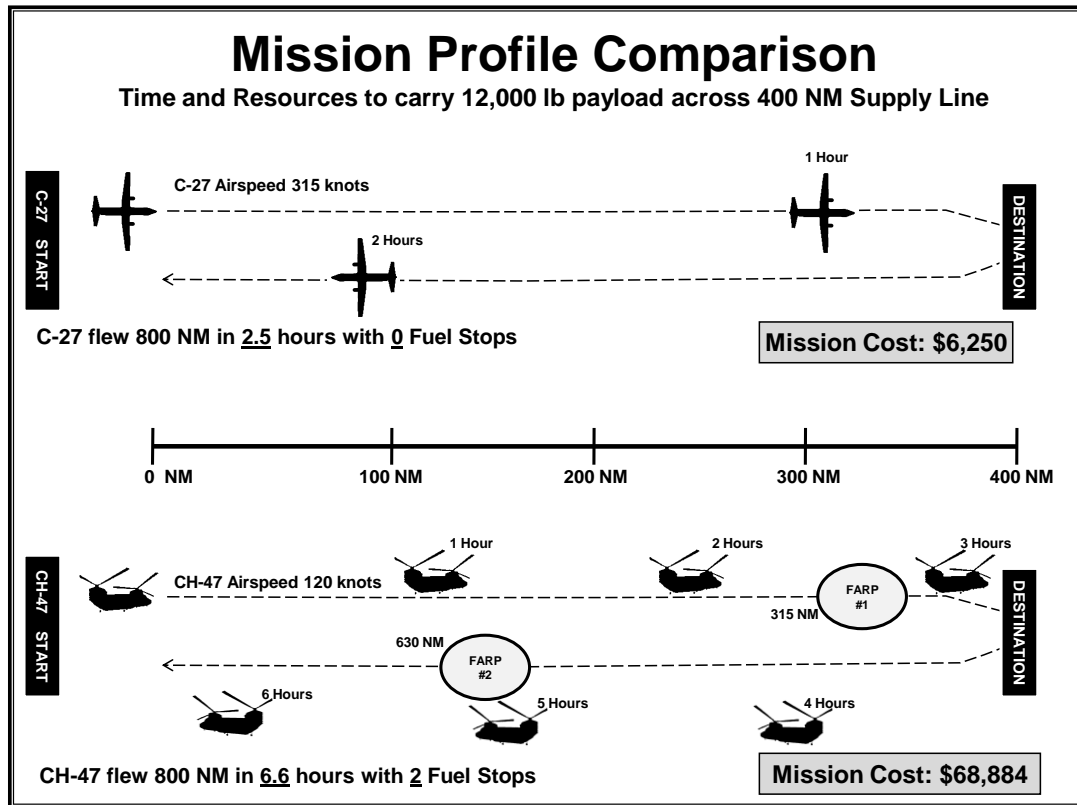


Figure 18. Mission Profile Comparison

Source: Created by the author.

Figure 19 provides an example of combining purchase and operating costs in an effort to consider initially buying and then operating these aircraft over a period of time. For example, if each aircraft is purchased and then operated for 6,000 flight hours, cost benefits can better be realized by operating the C-27J versus the CH-47. If the C-27J is purchased for \$26 million per unit and flown for 6,000 hours at \$2,500 per hour, the purchase and operating cost would be \$41 million. If the CH-47F is purchased for \$32 million per unit and flown for 6,000 hours at \$10,437 per hour, the purchase and operating cost would be \$94.6 million which is over twice the cost of the C-27J. This

example is intended to simply compare purchase and operating costs, and does not include a DOTMLPF analysis.

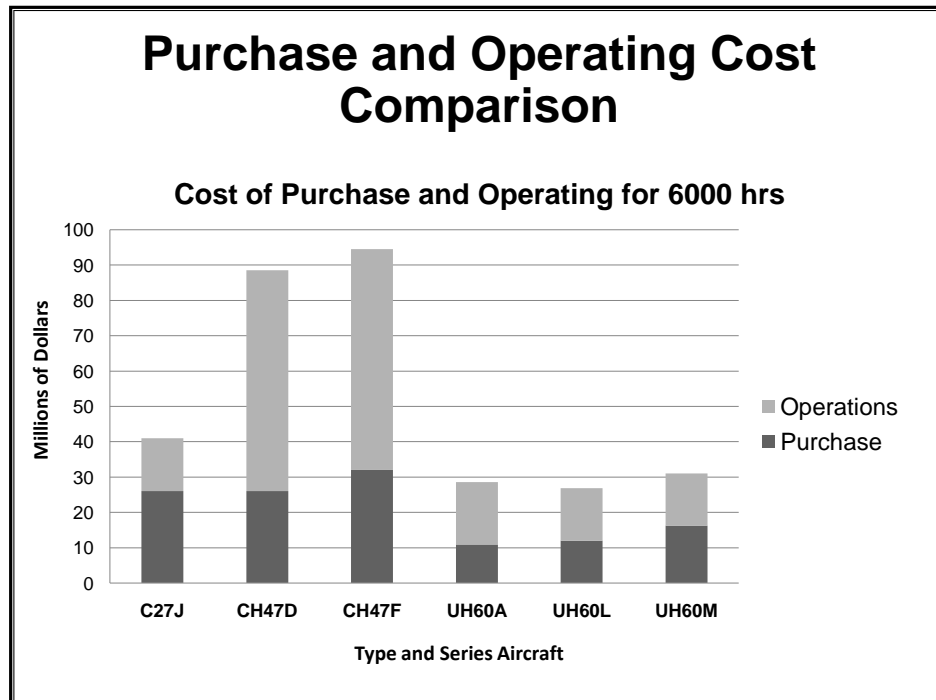


Figure 19. Purchase and Operating Cost Comparison  
*Source:* Created by the author.

### Conclusion

By operating the C-27J Spartan, the Army will have a greater organic fixed-wing airlift capability to fill the time and distance “airlift gap” and better meet Army intra-theater lift requirements. The Army will also save a significant amount of defense funds by acquiring and employing a greater number of fixed-wing aircraft to fly previously designated rotary-wing missions. The CH-47 Chinook and the UH-60 Blackhawk are highly maneuverable VTOL aircraft that can operate within confined areas and landing

zones. While the CH-47 has the capacity to carry more tonnage for short distances, the C-27J Spartan is a STOL aircraft that can carry heavy payloads over long distances quickly at a lower cost. Although the C-27J is not designed to replace the CH-47 or the UH-60, the aircraft is compatible with Army helicopters and Air Force cargo airplanes, due to its ideal transloadability and interoperability characteristics.

These aircraft complement each other's strengths and are extremely valuable intra-theater airlift assets as an integral part of the Joint Force. The C-27J will simply absorb much of the stress being placed on the Army's CH-47 and UH-60 helicopter fleets and is a highly capable, efficient, flexible and economically practical solution to conduct TS/MC "direct support" intra-theater airlift in support of the warfighter. With an understanding of why operating a larger number of airplanes to assume or supplement existing helicopter missions could be a more capable, flexible, economical and efficient solution to meeting Army airlift mission requirements, the next chapter will present conclusive remarks and make recommendations for Army airlift supporting current and future operations.

## CHAPTER 6

### CONCLUSIONS & RECOMMENDATIONS

#### Introduction

The United States Army will better meet intra-theater tactical airlift requirements and save a significant amount of defense funds by acquiring, integrating and employing a greater number of fixed-wing aircraft to assume or supplement existing utility and cargo helicopter missions. The C-27J Spartan purchased under the JCA program is the fixed-wing platform of choice to meet this function. This aircraft is central to Army Aviation modernization efforts since it is capable of transporting both Interim and Future Force intra-theater airlift requirements if purchased at adequate levels. The C-27J will bring a tremendous intra-theater transport capability to the Army because it has significant lift capacity, positive interoperability characteristics, mission profile efficiency, and favorable cost.

#### Interpretation of the Findings

Significant restrictions historically existed for Army Aviation to acquire fixed-wing aircraft and consequently the service has evolved into a helicopter-centric force with only a small fleet of airplanes. This 52 year long evolution was directly influenced by a series of legislative acts, formal service agreements, and defense department directives guided the fleet development of Army Aviation and operationally shaped the service's airmobility doctrine. Over the years, the Army has been sensitive to criticisms and consistently argued for the best in airmobility for its ground forces. Today, the Army is authorized to conduct airlift operations necessary to support service-organic mission

requirements, including fixed-wing airlift. The evolution of service responsibilities for intra-theater airlift missions has only been solidified by the 2006 JCA Memorandum of Agreement and the 2009 Quadrennial Roles and Missions Review Report. The Army is currently in a period of transformation; much like the service experienced while developing airmobile concepts in the 1960s. The difference is the Army and Air Force are entering a period of airlift cooperation as a result of the two services sharing the intra-theater airlift mission.

Currently, there is an existing time and distance intra-theater airlift “gap” while conducting FSO in the contemporary operating environment that needs to be filled with more light cargo aircraft. This gap in airlift capabilities exists between where inter-theater Air Force fixed-wing aircraft can deliver a payload to the theater and where Army fixed and rotary-wing aircraft can conduct intra-theater movement down to the point of need or effect. Under ideal conditions, operational and tactical airlift assets focus on moving payloads with high precision and timing with a balanced fleet of helicopters and light cargo airplanes. As the Army transforms from the Current to Interim to Future Force, this gap will only become more pronounced.

The Army conducts intra-theater airlift in the form of air movement, aerial sustainment and aeromedical evacuation with a mixed fleet of cargo and utility helicopters and airplanes. Helicopters are optimally suited for operating in the tactical role and not ideal for conducting intra-theater airlift over a 100 nautical mile combat radius, especially with heavy loads. In particular, Army helicopters like the CH-47 Chinook and UH-60 Blackhawk are too slow and lack the fuel range to move efficiently and effectively all the required quantities of supplies for ground forces engaged in

prolonged combat operations. The Army's current and only cargo airplane, the C-23 Sherpa, has lift capacity and performance limitations that prevent the aircraft from adequately filling the intra-theater airlift gap.

The extended use of helicopters to meet sustainment and battlefield circulation needs requires a robust support structure that entails an increased amount of aviation service resources and manpower. It also reduces the availability of tactical aircraft to conduct combat missions. Both come at a price of high operating costs and reduction in service-life of tactical airframes. Operating the newly acquired C-27J Spartan under the JCA program to assume or supplement helicopter missions will greatly assist with conducting aerial delivery to sustain combat maneuver, support and functional brigades, especially when operating across an expanded area of responsibility.

The primary goal of the JCA program was to procure a commercial light cargo aircraft that could be configured for military use and fly intra-theater airlift missions for the two services. When the C-27J Spartan was selected in 2007, the Defense Department approved the fielding of 78 aircraft from 2008 to 2013. Fifty four of these aircraft are scheduled to go to the Army and twenty four to the Air Force. Fielding began with the Army National Guard in September 2008. The Army plans to employ forty eight aircraft out in the field and utilize the remaining six aircraft for training. This equates to six C-27J fixed-wing companies with eight aircraft a piece within the Army's two existing Theater Aviation Battalions.

The value of the C-27J for the Army is realized through lift capability, fuel range and performance. With a maximum airspeed of 325 knots and service ceiling of 30,000 feet, the C-27J is capable of moving up to 25,350 lbs or 64 troops across distances

exceeding 1,100 nautical miles. Figure 20 graphically shows the operational reach of a C-27J operating at various parts of the globe and emphasizes the value of this aircraft. As a STOL-capable aircraft, the Spartan can take-off and land on remarkably short unimproved airstrips and the large rear cargo door and floor loading system facilitate payload handling. The C-27J is central to the modernization and increased capability of Army Aviation in that it is designed to meet current and anticipated intra-theater air mobility needs.

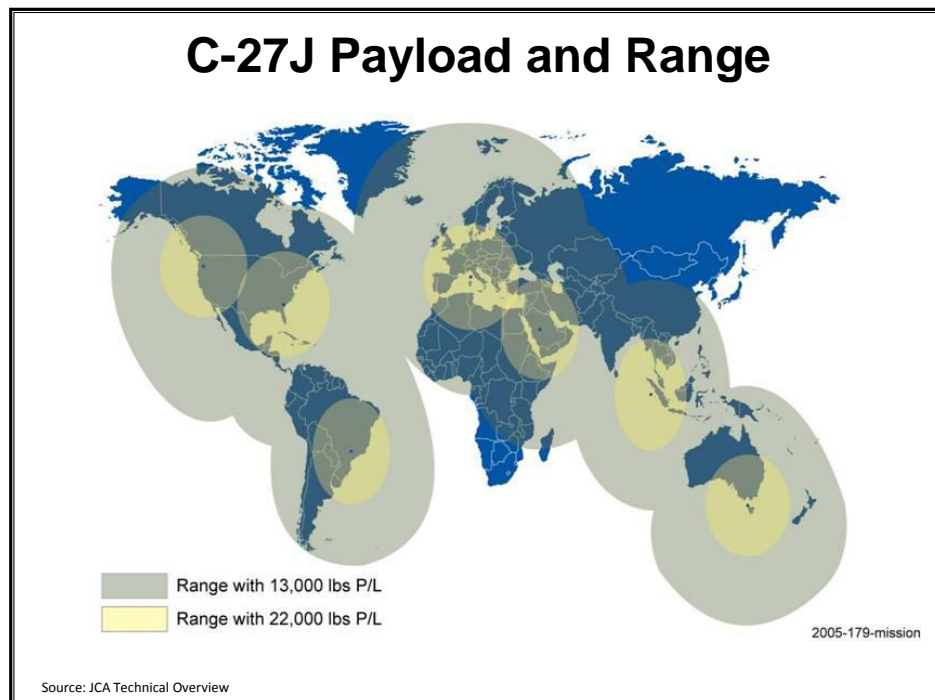


Figure 20. Payload and Range

Source: Army Fixed-Wing Program Office, *Joint Cargo Aircraft Overview Brief* (Redstone Arsenal, AL, 2008), 14.

It makes sense for the Army to have a greater organic fixed-wing airlift capability to fly intra-theater airlift missions in support of a modular and expeditionary force that



conducts FSO. Army Aviation exists to support the ground force and the C-27J Spartan is simply an exceptional and complimentary addition to an existing robust helicopter fleet. The effective application of dominant maneuver and focused logistics concepts depends upon the teaming of operational and tactical airlift. The Army is in the final stages of transforming to an expeditionary and modular force that centers its combat capability on the three types of BCT – Heavy, Stryker and Infantry – with varying and special mission sets. Supply lines from theater sustainment and supply sites to forward operating locations may exceed 400 miles with a requirement transport up almost seventy four short tons of cargo daily for each brigade deployed. These mobility and logistical support requirements surpass helicopter operational reach and demand bold aerial delivery application by more capable fixed-wing aircraft.

Employing a light cargo airplane like the C-27J Spartan is a far more capable, flexible, efficient and economical solution to meeting Army intra-theater airlift mission requirements. The service will conduct more effective intra-theater airlift and save a significant amount of defense funds by acquiring and employing a greater number of Spartans to assume or supplement helicopter utility and cargo mission sets. The Spartan is the best platform to transport a 25,000 lb payload to forward locations due to its superior performance and fuel range over every Army helicopter in the inventory. By evaluation of functional and practical lift capability with similar numbers of aircraft and payload weight, it is concluded that these helicopters will always be outpaced by the C-27J due to their slower airspeeds and shorter fuel ranges.

The weight carrying capacity and cargo compartment dimensions of the Spartan make it the perfect airlifter to fill the gap between inter-theater and tactical airlift. The

flexible transloadability characteristics facilitate timely, efficient and effective transport while integrating with Air Force C-5, C-17 and C-130 cargo airplanes and Army CH-47 and UH-60 helicopters. Efficiencies gained by flying faster airspeeds and greater flight performance have direct impacts to providing improved swift mission support to the warfighter across extended operational distances. The C-27J is a sound acquisition decision because cost savings are realized upfront and over the course of the program. With a cost per unit of \$26 million dollars each and an operating cost of \$2,500 per flight hour, a new C-27J is approximately \$6 million dollars less to purchase and \$7,900 less to operate than a CH-47F Chinook.

The versatility and value of the helicopter cannot be ignored or dismissed. Helicopters are highly maneuverable VTOL aircraft that can operate within confined areas and landing zones, a capability the Army depends on frequently. The CH-47 and UH-60 have the ability to move troops, equipment and supplies over short distances. The C-27J is a STOL-capable aircraft that can carry heavy payloads over long distances quickly at a lower cost. As a team of airlifters, these aircraft will simply complement each other's strengths. Above all, the C-27J Spartan will simply absorb much of the stress being placed on the CH-47 and UH-60 helicopter fleets and is a highly capable, efficient, flexible and economically practical solution to conduct effective intra-theater airlift in support of the warfighter.

### Recommendations

Based on an analysis of individual and collective lift capacity, the C-27J Spartan undeniably will bring tremendous intra-theater airlift potential to the Army. But the Army needs to have the capacity to deploy a greater number of C-27J working in concert

with CH-47 and UH-60 helicopters. The evidence shows that acquiring seventy two aircraft would be better than just fifty four because it will allow the service to field two more fixed-wing cargo companies. This course of action would allow sixty four aircraft to be assigned to the Army's two existing Theater Aviation Battalions and eight aircraft at the JCA Training Center. By having a fleet of sixty four aircraft within eight companies, the Army would have a significant airlift capability for most wartime or peacetime contingencies. The Army would also have better continuous support options by the capability to deploy twenty five percent of the fleet via two C-27J companies to a single site or multiple locations. Two of eight companies deployed support a 1:4 deployment-to-dwell time ratio which is advantageous to the goals of ARFORGEN deployment cycles. These increases in capability better balance Army Aviation cargo tonnage movement capability and allow more CH-47 and UH-60 helicopters to conduct tactical missions.

### Conclusion

The purpose of this study was to evaluate the United States Army's current and evolving cargo and utility aircraft fleet, and make recommendations for improving the service's ability to provide mobility, maneuver and sustainment support for ground forces. Army Transformation is causing the service to develop into a capabilities-based force that carries out operations across the spectrum of conflict. The Armed Forces are conducting operations in an era of persistent conflict and air assets are combat multipliers on the modern battlefield. Airlift requirements for ongoing conflicts and emerging operational concepts justify the need for the ability to conduct aerial delivery to more numerous and dispersed theater operating locations. The C-27J is absolutely central to

aviation modernization and advancement efforts due to its increased lift capacity, flexibility, efficiency and favorable cost. The value of the C-27J is evident by its ability to carry dense loads over extended distances and operate on austere airstrips. Through the teaming of the C-27J Spartan, CH-47 Chinook and UH-60 Blackhawk, the Army will conduct more effective intra-theater airlift in support of the warfighter while saving a significant amount of defense funds.

## APPENDIX A:

### KEY ACTS, AGREEMENTS, DIRECTIVES & MEMORANDUMS SINCE 1947

#### Post World War II Era

National Security Act (1947): This act mandated a major reorganization of the foreign policy and military establishments within the United States Government. The Department of Defense was created by merging the Navy and War Departments, and a separate Department of the Air Force was created and aligned under the new Department of Defense. For the military, the act was designed to make the services more efficient and less redundant.

Executive Order 9877 (1947): Simultaneously with the National Security Act of 1947, President Truman ordered and endorsed Executive Order 9877 to specify the different functions of each of the three armed services. The main areas of dispute were between the Air Force and Navy regarding a provision of air transport and responsibility of air warfare (Horwood 2006, 15). To a lesser degree, a dispute developed between the Army and Air Force over responsibility for air defense. The Army was given the latitude to provide for organic air and water transport. These concerns attributed to why the Key West Agreement was drafted in 1948.

Key West Agreement (1948): This agreement is the policy name for the informal name for a policy paper called “Function of the Armed Forces and the Joint Chiefs of Staff” written by the first US Secretary of Defense, James V. Forrestal. The agreement

attempted to reduce redundancy and inter-service rivalries between the various branched of the US Armed Forces by setting clear boundaries on roles and missions. This agreement was intended to provide a definitive, comprehensive statement of the functions of the armed forces and the Joint Chiefs of Staff (Horwood 2006, 15). A key feature of the agreement was a division of air assets between the Army, Navy and Air Force. The agreement stipulated that the Air Force would retain control of all strategic air assets, along with tactical combat and logistical support functions to support the Army. For the Army, the agreement stipulated the service would be authorized to operate smaller aircraft for reconnaissance and medical evacuation purposes.

Bradley-Vandenberg Agreement (1949): This agreement was signed by Army Chief of Staff General Omar Bradley and Air Force Chief of Staff Hoyt Vandenberg. This document recognized the principle Army Aviation functions as various surveillance missions in the immediate combat zone, emergency medical evacuation and limited aerial resupply. The agreement also defined certain aviation functions the Air Force would conduct in support of the Army. Unfortunately, many of the Air Force functions were broadly similar in many respects to Army Aviation roles, and even included medical evacuation, aerial resupply and aerial photography (Horwood 2006, 16). Under this agreement, Army fixed-wing aircraft were not to exceed 2,500 lbs empty weight while Army helicopters were not to exceed 4,000 lbs.

### Korean War Period

First Pace-Finletter Agreement (1951): The Korean War stimulated an expansion of Army Aviation with an increased number of aircraft with greater capability. This led to a

memorandum of understanding between Army Secretary Frank Pace and Air Force Secretary Thomas K. Finletter. The agreement was intended to be a compromise and ended weight restrictions for the Army, but better defines roles and missions for Army Aviation. The agreement limited Army Aviation to the provision of assistance in ground combat and logistics support in the combat zone not in excess of 50 miles deep (Horwood 2006, 22). The Army was also not to duplicate Air Force capabilities in reconnaissance, interdiction, close air support and troop airlift. Due to the technological advancement of helicopters, it was clear that the agreement would be short-lived.

Second Pace-Finletter Agreement (1952): This agreement re-imposed a weight limit for Army fixed-wing aircraft to 5,000 lbs and essentially lifted weight restrictions on helicopters under a special provision. The agreement specified that the Army aircraft could transport Army units, troops, equipment and supplies, but still restricted the Army from duplicating Air Force capabilities in reconnaissance, interdiction, close air support and troop airlift. The agreement sanctioned further incremental expansion of Army Aviation units in terms of total aircraft acquired and expanding roles and missions.

#### New Look and Pentomic Division Era

Wilson Memorandum, “Clarification of Roles & Missions to Improve the Effectiveness of Operation of the Department of Defense” (1956): New Look and the Army “Pentomic” reorganization caused Secretary of Defense Charles E. Wilson to better define roles and missions between the services. Army Aviation needed the capacity to rapidly disperse assets in the face of nuclear threat. The Wilson Memorandum limited Army Aviation to four primary functions: observation, airlift, medical evacuation and

liaison. The memorandum absolutely forbade Close Air Support operations by the Army, but allowed the Army to conduct organic airlift functions on a small scale as to not infringe upon the Air Force airlift mission (Horwood 2006, 27). This memorandum imposed a weight restriction of 20,000 lbs for Army helicopters and 5,000 lbs for fixed-wing aircraft. Further, the memorandum stipulated that Army Aviation could conduct support 100 miles to the rear and forward of the front. Note: The Secretary of Defense reserved the right to make special exceptions to the restrictions above, which would later be exercised by the Army with the procurement of the CV-2 Caribou and OV-1 Mohawk utilized during the Vietnam War.

Department of Defense Directive 5160.22, Roles & Missions for the Department of the Army & Air Force Regarding the Use of Aircraft (1957): This directive was signed by Secretary of Defense Charles E. Wilson and allowed the Army to operate aircraft for the purposes of C2, liaison, reconnaissance, observation/fire support adjustment, aerial surveying and organic airlift (limited to Army troops and materiel within the combat zone). The directive specified that it is the responsibility of the Air Force to conduct airlift from exterior points to the combat zone.

Defense Reorganization Act (1958): This act is an American law that was created to provide for a more effective administration of the Department of Defense by updating and improving authority channels for efficiency purposes (nationmaster.com 2009). The act moved decision-making authority from the Military Departments to the Secretary of Defense and Joint Chiefs of Staff. Further, it strengthened the command channels over the services from the President to the Secretary of Defense.



### Vietnam War Period

Williams and Powell Air Mobility Memoranda (1962): This memorandum to Secretary of Defense Robert McNamara proposed the formal establishment of an Army review board to identify and assess new formations and aircraft to recognize the concept of airmobility due to advances in technology in rotary-wing, VTOL and STOL aircraft. The memorandum argued that consideration should be given to forming airmobile infantry, reconnaissance, anti-tank and artillery units (Horwood 2006, 39). As a result, the Army formed the Tactical Mobility Requirements Board to explore new opportunities by Army aircraft.

McConnell-Johnson Agreement (1966): This agreement between the Army Chief of Staff General Harold K. Johnson and Air Force Chief of Staff General John P. McConnell formally recognized that the Army agreed to relinquish its fixed-wing tactical airlift fleet while the Air Force agreed to relinquish most types of helicopters in its inventory with the exception of those required for Combat Search & Rescue (CSAR) and special operations (Horwood 2006, 102). The Army subsequently transferred all CV-2 Caribou aircraft to the Air Force and relinquished claim to fixed-wing tactical airlift. The Air Force agreed to retain the CV-2 Caribou (later designated as the C-7) in the inventory and attach light cargo aircraft to Army units if required. The Army made use of innovative “airmobility” doctrine to quickly move troops and supplies. The Army subsequently steadily increased the use of more modern transport, observation and attack helicopters in Vietnam that influence and characterize the missions and functions of its aviation forces today.

### Reagan Era

Goldwater-Nichols Department of Defense Reorganization Act (1986): President Ronald Reagan signed the act into law October 1, 1986, in an effort to improve military advice to the senior leadership of the United States, provide clear responsibility to the combatant commands, and provide for more efficient use of the Armed Services. This act was sponsored by Senator Barry Goldwater and Representative Bill Nichols and caused the most significant change in defense reorganization since 1947 (National Defense University 2009). Goldwater-Nichols changed in the way the Department of Defense conducted operations and made joint operations the norm. Continued implementation of this act is an on-going project with Joint Vision 2010 (1996) and Joint Vision 2020 (2000).

### Global War on Terrorism

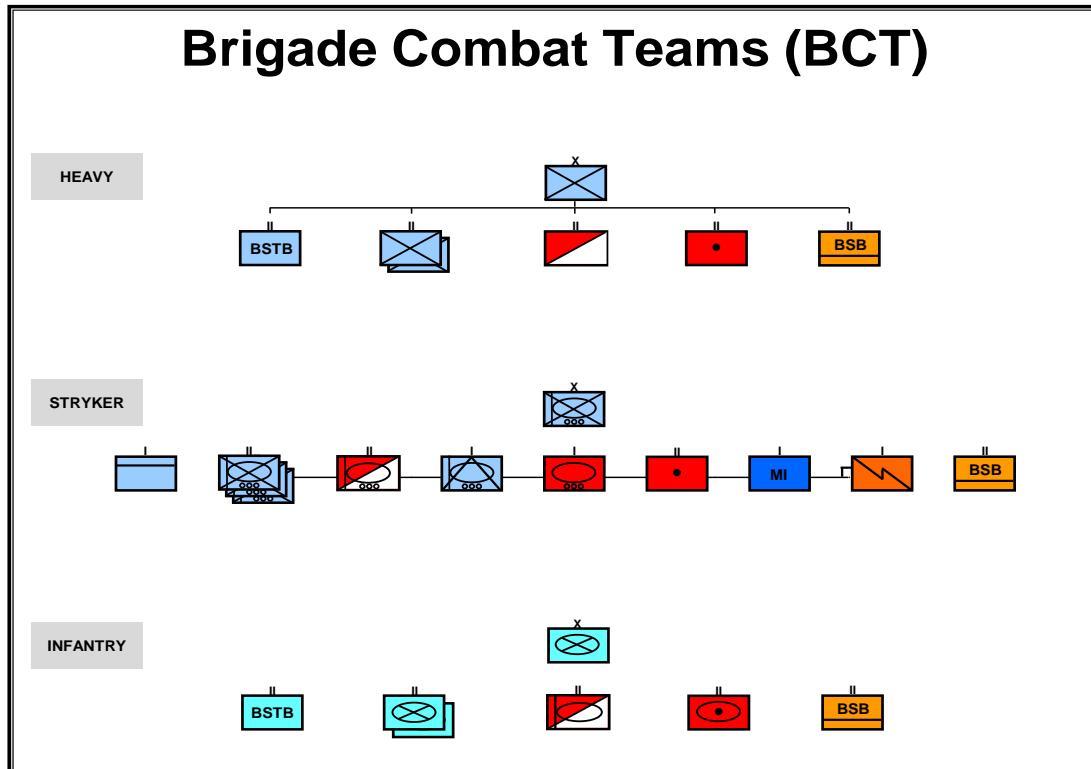
Department of Defense Directive 5100.1, Functions of the United States Armed Services (2003): This is the most current directive that orders the Air Force to organize, train, equip and provide forces for Close Air Support and air logistics support to the Army and other forces. These functions include: airlift, air and space support, airborne operations support, aerial photography, tactical air reconnaissance and air interdiction of enemy land forces and communication.

Joint Cargo Aircraft (JCA) Memorandum of Agreement (2006): This memorandum was signed by Army Vice Chief of Staff General Richard Cody and Air Force Vice Chief of Staff General John D.W. Corley. The memorandum acknowledges the merging of the

Army Future Cargo Aircraft (FCA) and Air Force Light Cargo Aircraft (LCA) programs into one Joint Cargo Aircraft (JCA) program. The document outlines the way ahead for the JCA programs and addresses roles and missions, command & control, sustainment, doctrine, standardization and training, service responsibilities and milestones.

## APPENDIX B:

### DIAGRAMS OF HEAVY, STRYKER AND INFANTRY BCT FORMATIONS

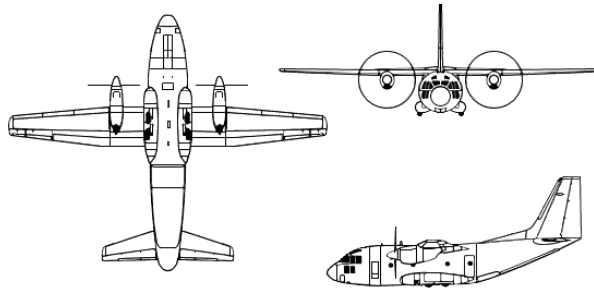


Source: Department of the Army, FM 3-90.6, *The Brigade Combat Team* (Washington, DC: Government Printing Office, August 2006), 2-7.

## APPENDIX C:

### AIRCRAFT SPECIFICATIONS

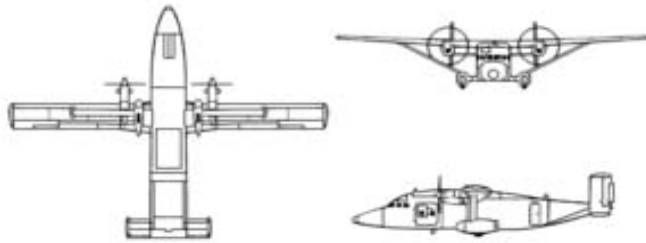
#### C-27J Spartan Cargo Airplane (Medium Lift)



<u>Mission:</u> Medium cargo intra-theater airlift, airdrop and aeromedical evacuation functions in support of state and federal missions. The primary roles of the C-27J are cargo transport, troop transport, and material and paratroop air drop. Other missions include tactical operations, medical evacuation, ground refueling, and fire-fighting support.	
Entered Army Service: 2008	
Maximum Takeoff Weight: 70,107 lbs	Maximum Payload Weight: 25,353 lbs
Maximum Speed: 325 knots / 374 mph	Maximum Service Ceiling: 30,000' MSL
Tactical Takeoff Run (MTOW, ISA, S.L.): 1,903 ft	Single Engine Ceiling (95% MTOW, ISA): 14,500' MSL
Landing Ground Roll (MLW normal, ISA, S.L.): 1,115 ft	
Range(s): 1,000 NM (25,000 lbs), 2,100 NM (13,200 lbs) or 3,200 NM Ferry Flight (No Payload)	
Troop Capacity: 46-68 troops (normal to high density)	Medical Evacuation: 36 patients or Litter Capacity 24
Minimum Crew: 4 (2 pilots, 1 flight engineer and 1 loadmaster)	

*Source:* The C-27J Website. *C-27J for the JCA Program.* <http://c27j.com>, (accessed on 20 October 2008).

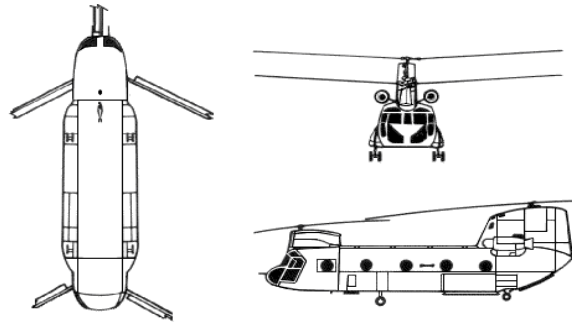
## C-23B Sherpa Cargo Airplane (Light Lift)



Mission: Light cargo intra-theater airlift, airdrop and aeromedical evacuation functions in support of state and federal missions. The C-23 has served the Army's intra-theater needs of cargo and personnel transport. It provides economic transport for time-sensitive personnel and cargo.	
Entered Army Service: 1985	Maximum Takeoff Weight: 25,600 lbs
Maximum Payload Weight: up to 7,000 lb of freight, including 4 LD3 containers, and engines up to F100 series	
Maximum Service Ceiling: 11,500' MSL (C-23A), 13,950' MSL (C-23B/B+)	
Maximum Speed: 190 knots at 10,000' MSL	Cruise Speed: 180 knots / 207 mph
Passenger Capacity: 30 troops or 27 paratroopers	Range: 750 miles with 5,000 lb payload
Minimum Runway Required: 1,850'	Medical Evacuation: 18 stretchers plus 2 medical attendants
Minimum Crew: 3 (2 pilots and 1 flight engineer)	

*Source:* Department of the Army, FM 3-04.613 *Utility and Cargo Fixed-Wing Operations* (Washington, DC: Government Printing Office, February 2003), C-2.

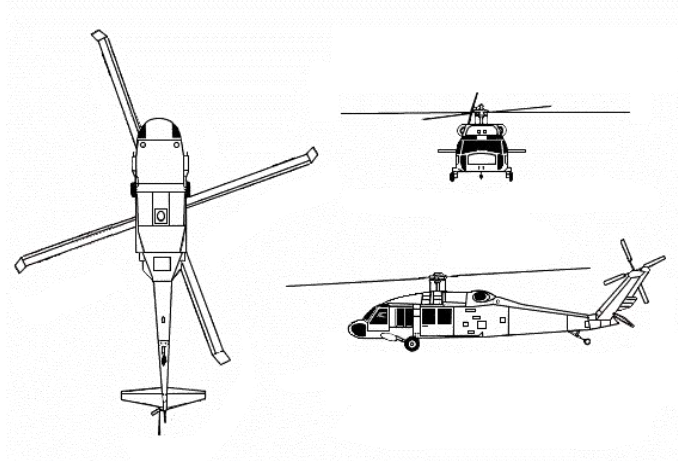
## CH-47F Chinook Cargo Helicopter (Heavy Lift)



<p>Mission: Transport ground forces, supplies, ammunition and other battle-critical cargo in support of worldwide combat and contingency operations. The CH-47D Chinook helicopter carries out “heavy lift” transportation of troops, artillery, supplies and equipment to the battlefield. It can carry 16,000 lbs of cargo internally or sling load 26,000 lbs of cargo. Other roles include medical evacuation, aircraft recovery, parachute drop, search and rescue, disaster relief, fire-fighting and heavy construction support.</p>	
Entered Army Service: 1962 (CH-47A), 2008 (CH-47F)	Max Gross Weight: 50,000 lbs
Empty Weight: 23,401 lbs	Normal Cruise Speed: 130 knots / 137 mph
Max Speed: 170 knots / 184 mph	Rate of Climb: 1,522 ft/min
Service Ceiling: 18,500 ft	Troop Capacity: 33 (normal) or 55 (high density)
Litter Capacity 24	Max Range: approx 340 NM
Minimum Crew: 3 (2 pilots and 1 flight engineer)	Max Endurance: approx 3.0 hrs (internal fuel)
Rotor System: 3 manual-folding blades per hub (two hubs); 225 rev per minute; 60-ft rotor span	
Sling-load Capacity: 26,000 lb center hook; 17,000 lb forward/aft hook; 25,000 lb tandem	
Armament: Two 7.62mm machine guns (side doors), One .50 cal machine gun (rear ramp)	

*Source:* Department of the Army, FM 1-100, *Army Aviation Operations* (Washington, DC: Government Printing Office, 1997), C-1 to C-9.

## UH-60L Blackhawk Utility Helicopter (Medium Lift)



<p>Mission: Provide air assault, general support, aeromedical evacuation, command and control and special operations support to combat and stability and support operations. In Air Assault operations the UH-60 can move a squad of 11 combat troops with equipment or reposition the 105 mm M102 howitzer with thirty rounds of 105 mm ammunition, and a four-man crew in a single lift. It can carry 2,600 lb of cargo or sling load 9,000 lb of cargo. The UH-60 is equipped with advanced avionics and electronics for increased survivability and capability, such as the Global Positioning System.</p>	
Entered Army Service: 1979	Max Gross Weight: 22,000 lbs / 23,500 (external cargo)
Max Speed: 193 knots / 222 mph	Normal Cruise Speed: 150 knots / 172 mph
Rate of Climb: 2,750 ft/min	Service Ceiling: 19,000 ft
Internal Load: 2640 lbs (or 11 combat-equipped troops)	Sling-load Capacity: 9,000 lb
Troop Capacity: 11	Litter Capacity: 6 (HH-60 MEDEVAC)
Minimum Crew: 4 (2 pilots; 2 crew chiefs)	Max Range: approx 306 NM
Armament: Two 7.62mm machine guns	
Rotor System: Four titanium and fiberglass blades; Diameter 53 ft 8 inch rotor span	
Max Endurance: approx 3.0 hrs (internal fuel), approx 3.5 hrs (external tanks)	

*Source:* Department of the Army, FM 1-100, *Army Aviation Operations* (Washington, DC: Government Printing Office, 1997), C-1 to C-9.



APPENDIX D:

IBCT, SBCT AND HBCT CONSUMPTION RATES AND RESUPPLY  
REQUIREMENTS

IBCT Sustainment Requirements							
One Day of Supply							
Class	Rate	Gallons	LBS	STONS	Pallets	20' Containers	% Dry Cargo
Class I	8.56		30,191	15.10	67	4.2	28.0%
Class II	2.03		7,160	3.58	18	1.1	6.6%
Class III (B)	Average	20,689					
Class III (P)	Average		949	0.47	2	0.1	0.9%
Class IV Barrier/Fortification Construction	2.34		8,253	4.13	16	1.0	7.6%
	2.03		7,160	3.58	14	0.9	6.6%
Class V	Average		14,476	7.24	9	0.6	13.4%
Class VI	0.42		1,481	0.74	4	0.3	1.4%
Class VII	Average		6,014	3.01	15	0.9	5.6%
Class VIII (Soldier Based Only)	0.15		529	0.26	3	0.2	0.5%
Class IX	Average		3,283	1.64	7	0.4	3.0%
Water	1.65	2,910					
	50.0%		24,268	12.13	10	0.6	22.5%
	3.52	12,415					
	0	0					
Ice	3.5		12,345	6.17	5	0.3	11.4%
Mail	1.18		4,162	2.08	7	0.4	3.9%
<b>Total Dry Cargo</b>			<b>107,925</b>	<b>54</b>	<b>172</b>	<b>11.0</b>	<b>100%</b>
<b>Total Fuel (Gallons)</b>		<b>20,689</b>					
<b>Total Water (Gallons)</b>		<b>15,325</b>					
<b>Total Ice</b>			<b>12,345</b>	<b>6</b>	<b>5</b>	<b>1.0</b>	

SBCT Sustainment Requirements							
One Day of Supply							
Class	Rate	Gallons	LBS	STONS	Pallets	20' Containers	% Dry Cargo
Class I	8.56		34,086	17.04	76	4.8	23.7%
Class II	2.03		8,083	4.04	20	1.3	5.6%
Class III (B)	Average	26,122					
Class III (P)	Average		1,122	0.56	2	0.1	0.8%
Class IV Barrier/Fortification Construction	2.34		9,318	4.66	18	1.1	6.5%
	2.03		8,083	4.04	16	1.0	5.6%
Class V	Average		27,067	13.53	17	1.1	18.8%
Class VI	0.42		1,672	0.84	4	0.3	1.2%
Class VII	Average		3,007	1.50	8	0.5	2.1%
Class VIII (Soldier Based Only)	0.15		597	0.30	3	0.2	0.4%
Class IX	Average		18,609	9.30	37	2.3	12.9%
Water	1.65	3,285					
	50.0%		27,398	13.70	11	0.7	19.1%
	3.52	14,017					
	0	0					
Ice	3.5		13,937	6.97	6	0.4	9.7%
Mail	1.18		4,699	2.35	8	0.5	3.3%
<b>Total Dry Cargo</b>			<b>143,743</b>	<b>72</b>	<b>220</b>	<b>14.0</b>	<b>100%</b>
<b>Total Fuel (Gallons)</b>		<b>26,122</b>					
<b>Total Water (Gallons)</b>		<b>17,302</b>					
<b>Total Ice</b>			<b>13,937</b>	<b>7</b>	<b>6</b>	<b>1.0</b>	

## HBCT Sustainment Requirements One Day of Supply

Class	Rate	Gallons	LBS	STONS	Pallets	20' Containers	% Dry Cargo
Class I	8.56		32,965	16.48	73	4.6	22.3%
Class II	2.03		7,818	3.91	20	1.3	5.3%
Class III (B)	Average	55,999					
Class III (P)	Average		3,740	1.87	6	0.4	2.5%
Class IV	Barrier/Fortification		9,011	4.51	18	1.1	6.1%
	Construction		7,818	3.91	15	0.9	5.3%
Class V	Average		29,138	14.57	18	1.1	19.7%
Class VI	0.42		1,617	0.81	4	0.3	1.1%
Class VII	Average		15,083	7.54	37	2.3	10.2%
Class VIII (Soldier Based Only)	0.15		578	0.29	3	0.2	0.4%
Class IX	Average		8,885	4.44	18	1.1	6.0%
Water	Bulk Drinking - Potable	1.65	3,177				
	PKG Drinking - Potable	50.0%	26,497	13.25	11	0.7	17.9%
	Other - Potable	3.52	13,556				
	Non_Potable	0	0				
Ice	3.5		13,479	6.74	6	0.4	9.1%
Mail	1.18		4,544	2.27	8	0.5	3.1%
<b>Total Dry Cargo</b>			<b>147,693</b>	<b>74</b>	<b>231</b>	<b>15.0</b>	<b>100%</b>
<b>Total Fuel (Gallons)</b>		<b>55,999</b>					
<b>Total Water (Gallons)</b>		<b>16,733</b>					
<b>Total Ice</b>			<b>13,479</b>	<b>7</b>	<b>6</b>	<b>1.0</b>	

Source: United States Army Combined Arms Support Command website. *OPLOG Planner*. <http://cascom.army.mil/cdi/FDD/Multi/PDB/ArmyLogisticsPlanningData.HTM>, (accessed on 23 February 2009).

## REFERENCE LIST

- Air Mobility Command. 2007. Concept of operations (CONOPS) for joint cargo aircraft (JCA). Scott AFB, IL: US Government Printing Office.
- Aircraft Rates. Office of the Secretary of Defense (Comptroller) Website. *FY2009 reimbursable rates – fixed wing*. <http://www.defenselink.mil/comptroller/rates/>, (accessed 26 October 2008).
- Aircraft Rates. Office of the Secretary of Defense (Comptroller) Website. *FY2009 reimbursable rates – rotary wing*. <http://www.defenselink.mil/comptroller/rates/>, (accessed 26 October 2008).
- Army Future Cargo and Utility Aircraft Initial Capabilities Document (ICD) Development Team. 2005. *Initial capabilities document for aerial sustainment capability*. Fort Rucker, AL: Department of the Army.
- Army Future Cargo and Utility Aircraft Capabilities Development Document (CDD) Development Team. 2005. *Capabilities development document for aerial sustainment capability*. Fort Rucker, AL: Department of the Army.
- Army News Service. The Army News Service website. *Army, AF announce joint cargo aircraft program*. <http://www4.army.mil/news/article.php?story=8731> (accessed 5 January 2009).
- Army Weapons Systems. United States Army Fact File website. *Army aircraft*. <http://www.army.mil/factfiles/equipment/aircraft/index.html> (accessed 25 February 2009).
- Baker, David. 1989. *Military airlift library: airlift*. Vero Beach, FL: Rourke Enterprises, Inc.
- Butler, Amy. “SOF to convert one C-27J to gunship lite.” *Aviation Week* (25 July 2008).
- C-27J Spartan. The C-27J Website. *C-27J for the JCA program*. <http://c27j.com>, assessed on 20 October 2008.
- Defense Reorganization Act of 1958. Nationmaster website. *Defense reorganization act of 1958*. [www.nationmaster.com/encyclopedia/defense-reorganization-act-of-1958](http://www.nationmaster.com/encyclopedia/defense-reorganization-act-of-1958) (accessed on 22 January 2009).
- Department of the Air Force, AFPAM 10-1043, *Air mobility planning factors* (Washington, DC: 18 December 2003). US Government Printing Office.
- Department of the Army. FM 55-450-2, *Army helicopter internal load operations*. (Washington DC: 5 June 1992). US Government Printing Office.

- . FM 4-20.41, *Aerial delivery distribution in the theater of operations*. (Washington DC: August 2003). US Government Printing Office.
  - . FM 1-100, *Aviation operations*. (Washington DC: February 1997). US Government Printing Office.
  - . FM 3-04.111, *Aviation brigades*. (Washington DC: December 2007). US Government Printing Office.
  - . ARTEP 1-118.MTP, *General support aviation battalion*. (Washington DC: January 2006). US Government Printing Office.
  - . FM 3-0, *Operations*. (Washington DC: February 2008). US Government Printing Office.
  - . FM 3-90.6, *The brigade combat team*. (Washington DC: August 2006). US Government Printing Office.
  - . FM 3-04.613, *Utility and cargo fixed wing operations*. (Washington DC: February 2003). US Government Printing Office.
  - . *Functional area analysis for army aviation operations capabilities based assessment 2015-2024*. (Fort Rucker, AL: 29 October 2008).
  - . MTMCTRA PAM 700-2, *Logistics handbook for strategic mobility planning*. (Washington DC: October 2006). US Government Printing Office.
  - . *United States army utility and cargo helicopter lift analysis: support for army needs and requirements*. Redstone Arsenal, AL: 30 June 2008.
  - . *The United States army concept capability plan for army aviation operations 2015-2024*. (Washington DC: 12 September 2008).
  - . *The United States army transformation roadmap*. Washington DC: Government Printing Office 2003.
  - . *Vietnam studies: airmobility 1961-1971*. Washington DC: Government Printing Office 1989.
- Department of Defense. *JP 1-02, Department of defense dictionary and associated terms*. (Washington DC: 17 October 2008). US Government Printing Office.
- Goldwater-Nichols Department of Defense Reorganization Act of 1986. National Defense University website. *Goldwater-nichols department of defense reorganization act of 1986*. [www.ndu.edu/library/goldnich.html](http://www.ndu.edu/library/goldnich.html) (accessed 22 January 2009).

- Harding, Stephen. *US army aircraft since 1947: an illustrated refernce*. Atglen, PA: Schiffer Military History, 1997.
- Horwood, Ian. *Interservice rivalry and airpower in the Vietnam war*. Fort Leavenworth: Combat Studies Institute Press, 2006.
- Jackson, Paul. *Jane's all the world's aircraft*. Alexandria, VA: Jane's Information Group, Sentinel House, 1992.
- . *Jane's all the world's aircraft*. Alexandria, VA: Jane's Information Group, Sentinel House, 2006.
- Knight, William. *Military airlift: the joint cargo aircraft program*. Congressional Research Service. Washington DC: US Library of Congress, December 2007.
- Lundh, Lennart. *US army aviation color schemes and markings 1942 to present*. Atglen, PA: Schiffer Military History, 2000.
- Matricardi, Paolo. *US army aviation color schemes and markings 1942 to presthe great book of combat aircraftt*. New York, NY: Metro Books, 2006.
- Miles, Donna. "Army moving toward more joint, capable aircraft ." American Forces Press Service (19 July 2006).
- Putrich, Gayle S. "First C-27Js delivered to the army." *The Army Times* (28 September 2008).
- Soukhanov, A. H. (Ed.). (1988). *Webster's II new riverside university dictionary*. Boston: Houghton Mifflin Company.
- Tiron, Roxana. "Army receives full funding for joint cargo aircraft." *The Hill* (25 September 2008).
- Trimble, Stephen. "Unmanned cargo aircraft 'have battlefield role' says US army official." *Flight Global* (5 February 2009).
- US Army Aviation Center Directorate of Combat Developments, *Capabilities development document for the United States army future cargo aircraft*, 2005). Ft Rucker, AL, April 2004.
- . *Initial Capabilities Document for aerial sustainment capability*, 2005). Ft Rucker, AL, 26 January 2005.
- U.S. Army. Command and General Staff College. *Integrating joint intra-theater airlift command and control with the needs of the modular army: a perspective of current and past nonlinear operations*. Ft. Leavenworth, KS: USA CGSC, June 2008.

US Army, Directions for Defense, *Report of the commission on roles and missions of the armed forces*, May 1995. Ft Sam Houston, TX, May 1995.

Veronico, Nicholas and Dunn, Jim. *Giant cargo aircraft*. Osceola, WI: MBI Publishing Company, 1999.

Winchester, Jim (Ed.). (2005). *American military aircraft: a century of innovation*. New York: Metro Books.

## INITIAL DISTRIBUTION LIST

Combined Arms Research Library  
U.S. Army Command and General Staff College  
250 Gibbon Ave.  
Fort Leavenworth, KS 66027-2314

Defense Technical Information Center/OCA  
825 John J. Kingman Rd., Suite 944  
Fort Belvoir, VA 22060-6218

Mr. David W. Christie  
DJIMO  
USACGSC  
1 Reynolds Ave.  
Fort Leavenworth, KS 66027-1352

Dr. Sean N. Kalic  
DMH  
USACGSC  
1 Reynolds Ave.  
Fort Leavenworth, KS 66027-1352

Mr. Stephen M. Melton  
CTAC  
USACGSC  
1 Reynolds Ave.  
Fort Leavenworth, KS 66027-1352